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CONTRIBUTIONS TO THE DEVELOPMENT OF SOIL MICROBIOLOGY FROM THE SOUTHEASTERN UNITED STATES[1, 2]

By Dr. F. B. SMITH

MICROBIOLOGIST, FLORIDA AGRICULTURAL EXPERIMENT STATION, UNIVERSITY OF FLORIDA; CHAIRMAN, SUBCOMMITTEE ON SOIL MICROBIOLOGY, SOUTHEASTERN AGRONOMY RESEARCH COMMITTEE

SOIL microbiology may be defined as that branch of science which treats of the microorganisms in soils, their character, life-history and function *and their relationships to the fertility or crop-producing power of the soil.* It is not enough to isolate microorganisms from the soil, to study them in pure culture, to characterize and classify them to define the science. The relationships of the microorganisms to the crop-producing power of the soil is fundamental in the concept of the science.

It is quite generally known, by the soil microbiologist at least, that productive soils contain greater numbers of microorganisms than unproductive soils and that those soil management practices which have proved to be effective in building soil fertility also stimulate desirable microbiological action in soils. However, to many who make a business of growing plants, even this does not indicate the very close relationship of the soil microorganisms to the growth of plants. To fully appreciate the almost complete de-

[1] Abstract of report presented at the Association of Southern Agricultural Workers, Memphis, Tennessee, February, 1942.

[2] The assistance of the Southeastern Agronomy Research Committee is gratefully acknowledged.

pendence of higher plants upon the soil microorganisms one only needs observe the growth of plants in a sterile system. In many cases it is impossible to grow plants to their normal, full development without the organisms, and where it can be done it is usually attended with great difficulty. Another example which emphasizes this interdependence of higher plants and soil microorganisms is the fact that barren soils are also almost always sterile soils. A soil may contain adequate mineral plant food constituents and still be unproductive, unless it contains the proper soil microorganisms.

Soil microbiology is a relatively new science, but youth in this case does not imply lack of development. It was just sixty years ago that Koch developed the gelatin plate method of studying microorganisms and much of the foundation work of the new science was done during the next twenty years following this discovery. Nitrogen fixation by bacteria in association with leguminous plants was proved, the causative organisms were isolated and described and artificial inoculation was practiced during this time. Nitrogen fixation by the non-symbiotic bacteria was proved and the free-living nitrogen-fixing bacteria were isolated and described. The production of ammonia and nitrates was proved to be biological and the nitrifying bacteria were isolated and described. The physiological processes of nitrogen fixation, nitrification, ammonification and organic matter decomposition were established and the physiological groups of microorganisms were recognized. The stage was set for exploitation and the development of trends in soil microbiological investigations.

The pure culture methods of study followed by the medical bacteriologist and the systematist were favored by many and for a time extending into the first decade of the next century the favorite pastime of the soil microbiologist seemed to be the identification of new species. The determination of numbers of bacteria in different soils, at different depths and under various conditions received the attention of many soil microbiologists during the formative period. This phase of the science is still in the process of development and much of the earlier work on numbers and kinds of organisms in the soil can be profitably reviewed. Since much of this work was done a new concept of the soil body has been established. Relatively little of the earlier work was done on a soil-type basis. We know now that soils differ one from another and we do not expect to find the same microbiological characteristics in all soils. From the beginning the influence of the agronomist in shaping the direction of soil microbiological investigations was evident. This was a rather fortunate circumstance for several reasons. This influence figured largely in the present concept of the science and was a large factor in the rapid development of soil microbiology as a definite branch of science.

It is no longer considered adequate to study the soil microorganisms in pure culture, important as that may be, but it is now regarded not only desirable but imperative to study the soil microorganisms in their natural habitat. Biological interactions are known to be important and new techniques are being developed to study the soil microorganisms as they live in the soil. In 1939 it was stated by a high medical authority that the most outstanding development in medical science that year was contributed by a soil microbiologist who discovered that certain of the pathogenic bacteria were killed by minute quantities of a substance produced by soil microorganisms.

Since 1887, when Hellriegel and Wilfarth proved that nitrogen fixation was accomplished by bacteria in association with leguminous plants, the nature of the partnership of the bacteria with the higher plants, the benefit derived by the microorganisms and the mechanism of the fixation of nitrogen have been questions asked by all and problems which have baffled the efforts of the soil microbiologist. In recent years considerable progress has been made in these investigations. The enzymatic nature of the process, the isolation of factors specific for nitrogen fixation, the effect of hydrogen ion concentration on respiration and growth of the organisms are recent advances to our knowledge of the subject. The new techniques now available and being developed bid fair to a clarification of the mysteries of the process.

Space will not permit a complete review of all the outstanding developments in soil microbiology, even during the last decade. However, enough has already been said to show the great interest in the science, the progress that has been made and to indicate the future possibilities for the investigator with imagination and industry. It is not at all unreasonable to expect new soil management practices, cropping systems, rotations, more intelligent use of green manures, manures and fertilizers based on microbiological action in soils when sufficient information is at hand concerning the effects of these treatments on the complex soil flora and fauna and the biological interactions in the soil.

Between 1909 and 1916, Stevens and Withers and associates at North Carolina, studying the process of ammonification and nitrification, recognized for the first time the importance of the soil as a culture medium. Further studies on ammonification and nitrification were carried out at the Georgia Station and reports were published by Owen in 1908 and Temple in 1919. Extensive studies reported by Temple in 1916 on the efficiency of commercial cultures for legume inoculation showed the superiority

of the soil as a culture medium for the legume bacteria.

After the first wave of enthusiasm which had just about subsided by the time of World War I, soil microbiological investigations were practically nonexistent in southeastern institutions, at least few reports of research appeared between 1919 and 1929. During recent years there has been a revival of interest in soil microbiological investigations in the Southeast. North Carolina state, a pioneer in soil microbiology in this country, and one of the first states in the South to do research in this field, returned to production again in 1929 with a report by Shunk on microbiological activities in the soil of an upland bog in eastern North Carolina.

At the Kentucky Station extensive studies have been underway on the associative growth of legumes and non-legumes, the inoculation of soybeans and the effect of lime on the inoculation of alfalfa. Karraker has published reports on these and other phases of the nitrogen balance in soils since 1925. The effect of oxidation of sulfur in limed and unlimed soils, and the influence of sulfur and gypsum on the solubility of potassium in soils and on the quantity of this element removed by certain plants are reports from the Kentucky Station by Shedd.

Reference to the publications on legume inoculation will indicate the importance attached to soil microbiological investigations at the Mississippi Station. Numerous investigations in this field have been reported in recent years by Andrews, and Briscoe and Andrews. The results of these investigations undoubtedly will play a large part in the future in the management of southern soils.

Previous to 1937 the work in soil microbiology in Florida centered around nitrogen fixation with the contributions of Carroll on cross-inoculation groups in the genus Rhizobium and the work of Mowry on nitrogen fixation by Casuarina. Beginning the fiscal year 1938 four projects in the field of soil microbiology were approved by the Agricultural Experiment Station. Recently papers on the effect of soil reaction on the decomposition of organic matter, the effect of phosphate fertilizers and lime on the nodulation of legumes, and a preliminary report on the algal flora of some Florida soils have been published.

Until late in 1940, there was no personnel at the Alabama Agricultural Experiment Station directly charged with the investigation of soil microbiological problems. However, a number of investigations in this field were carried out previous to that time. Duggar and Rogers and Sturkie published reports dealing with root nodule formation on various winter and summer leguminous plants.

At the South Carolina Station, Peele, Peele and Wilson and Peele and Beale have published important findings on the distribution of legume bacteria in the Piedmont soils of South Carolina, the influence of microbial activity upon aggregation and erodibility of lateritic soils, and microbial activty in relation to soil aggregation.

More important than a listing of the publications of work that has been done in the field of soil microbiology during recent years, significant as that may be, is the array of projects now underway at the various institutions.

The principal problem being investigated at the Alabama Agricultural Experiment Station at present deals with the influence of biological activity on those qualities that affect the hydrologic aspects of soil and water conservation. In addition to this study, some attention is being given to the nature of microbiological activities in "gall-spot" soils in comparison to those in nearby fertile areas. Studies on the "stubble mulch" method of handling crop residues are also contemplated for the future.

At the Kentucky Station research being carried out but not yet completed are nitrogen balances as related to soil management, nitrogen fixation and disposal under continuous cropping of various legumes and of these legumes in association with bluegrass, and nitrogen excretion by legumes.

The use of soil for the inoculation of vetch and cross-inoculation of the Rhizobia found on wild lespedeza are projects under investigation at the Mississippi Station at present.

Projects underway in North Carolina are nitrification studies in forest soils, possible control of plant pathogenic bacteria in soil by chemical means and microbial antagonisms in soil that may aid in control of plant pathogenic bacteria.

Research underway but not yet completed at the Florida Station consists of a number of problems carried under the following projects: Types and distribution of microorganisms in Florida soils, the metabolism and functional relations of soil microorganisms under Florida conditions, the interrelationships of microorganisms in soil and cropping systems in Florida, and the factors affecting the growth of legume bacteria and nodule development. Cooperation has been established with the Agronomy Department on all phases of the work and with the Entomology Department on the interrelationships of microorganisms in the soil that may aid in the control of rootknot by nematodes.

Further studies on microbial activity in relation to soil aggregation are in the process of completion by Peele in South Carolina and work is contemplated on the decomposition of organic matter, the rate of decomposition of lignin and hemicellulose, the relative

value of mulches and incorporated organic matter and the nitrogen-fixing bacteria.

The projects listed above under active investigation at six institutions in the region is convincing proof of the interest in this field of work. No doubt other investigations at institutions not contacted or reported here are underway. The situation is most encouraging, and it is to be hoped that much progress will be made in all lines of soil microbiological work during the next few years. In spite of all the work that has been done and that which is under way, there are many unsolved problems in this field. The inoculation of legumes has not been uniformly successful, even if it is one of the oldest applications of the science. Much information has been gained concerning the factors affecting the growth of the Rhizobia, but we still know very little about the relative efficiency of different strains of the organisms. Although a few studies have been made on the effects of certain organisms on the growth of Rhizobia very little is known concerning the relationship of these organisms with the complex flora of the soil. The presence of Rhizobiumphage has been noted, but only scanty information is available concerning the occurrence and action of this bacteriophage. In spite of all the work of the past few years on the chemistry of nitrogen fixation much remains to be determined concerning the metabolism and functional relationships of the nitrogen-fixing microorganisms. It is still uncertain whether the Rhizobia fix nitrogen apart from the host plant. Nodule formation is met with in many plants other than the leguminosae, yet it is not known definitely whether symbiotic nitrogen fixation occurs in all cases. The interactions of soil microorganisms and the higher plants, of which mycorrhiza formation is another special case, is a field rich in possibilities. Since the soil microorganisms are plants it seems logical that the biological tests for the availability of plant food constituents and the determination of the fertilizer needs of soil should be more satisfactory than chemical tests. Although several of these tests have been under investigation from time to time, no procedure has been developed which does not leave much to be desired. Soil microbiology is still a virgin field. Many of the earlier findings in other regions are still to be confirmed on our soil types.

THE AMERICAN FEDERATION FOR CLINICAL RESEARCH[1]

By Dr. MAURICE A. SCHNITKER
TOLEDO, OHIO

MY decision to give a chairman's address at this first annual meeting of the society was prompted by my great desire to tell you more about the American Federation for Clinical Research. This new society, which had its conception, birth and successful launching last year in Atlantic City, through the efforts of Dr. Henry A. Christian, of Boston, is a society which is different, and I hope will remain so, from many other similar organizations.

The organization meeting of the federation was held in Chalfonte-Haddon Hall last year, during the meetings of the Association of American Physicians and the American Society for Clinical Investigation. There were over 300 at the meeting, and although all of us were very enthusiastic, those of us who were chosen as your officers had much to learn concerning the details which the founder had in mind when this new society was drafted. It is some of these details, with which Dr. Christian has been most gracious and helpful, that I would like to present to you, and to be passed on to others, for a better understanding of the society.

First, I would like to discuss individual membership. Any young man or woman interested in and doing investigation in any branch of medical science, or allied fields, is eligible for membership in the American Federation for Clinical Research. This includes medicine, surgery, obstetrics, gynecology, pediatrics, pathology, bacteriology, chemistry, physics, and so on, any branch of science which deals with the healing art. Any one of any age so qualified may become a member, but individuals under 35 years of age are preferred. It has been adopted that no one over the age of 40 may hold an office in this society, and to follow somewhat the precedent of last year's meeting, none over the age of 40 is to appear on the program of the national meeting or to raise a voice in discussion at the national meeting. In effect, then, it is truly a society for *young* investigators and run entirely by *young* investigators.

There is no numerical limitation to the society.

However, if one is of the correct age group, it is not sufficient to say that one is interested in investigation. There must be tangible evidence in the form of at least one completed piece of research. Now what constitutes a piece of research may not be so easy to define. That was one of the first subjects discussed at the first council meeting last May in At-

[1] Address of the president, delivered at the first annual meeting, Minneapolis, Minnesota, April 20, 1942.

lantic City. It was there decided that a single interesting case report is not sufficient. The work of investigation should have a question involved, with work carried out in a manner attempting to answer that question. It may be in the form of a statistical analysis of bedside or laboratory observation or an original experimental piece of research. Whichever method is used, the investigator should be endeavoring to answer one or several questions by the work done. What this attempts to do is to place the criterion high enough to make the membership be of value to the individual, in that it must be acquired, but at the same time does not place membership beyond reach of the majority. It is a means whereby membership is attained by the individual through his own merits. For this society does not require, and wishes to dispense with, letters of recommendation in order to obtain membership. This places the full responsibility upon the individual and the work he can produce.

The constitution states further that "membership will continue so long as the member maintains interest in investigation by periodic publication of papers based on research." What is meant by the word "periodic" has not yet been defined, and what shall constitute evidence of "continued interest" is a question for the future; probably it is wisest not to attempt now or in the future a categorical definition with a membership primarily interested in investigation. The spirit of these terms doubtless is all that will be needed. "Forced research" and "forced attendance" seem to your president undesirable. By "forced research" I mean forced attendance at meetings and the presentation of papers at stated intervals. Forced attendance at meetings, by members of limited income such as make up our society, can soon lead to loss of interest. And forcing members to read a paper at least every two or three years is undesirable. Best investigations often come at long intervals. This is a society composed of young men interested in carrying on research. Many of them are in the practice of medicine and of them the same amount of research work is not to be expected as from those who spend the entire day in the laboratory. Furthermore, a forced piece of investigation done to meet the requirements of appearing on some program seldom amounts to much. Good research must be inherent and come spontaneously from the individual. It can not be hurried. Some work more slowly than others. In this society it is hoped that by not restricting its membership numerically and by not forcing presentation of papers there always will be sufficient titles submitted to fill a program with papers that have been inspired by the desire of the individual to solve a problem and not merely for the purpose of getting on a program in order to maintain membership in the society.

Several have asked whether the society will have a publication, a Transactions, to contain the various papers. For the present time it has been considered not advisable, and members are left free to publish papers anywhere they choose.

The inability of members to afford yearly attendance at the annual meeting, much as it may be desired, has been overcome in this new society in two ways, according to the plan outlined by Dr. Christian. The first is to hold the annual meeting in conjunction with the meeting of some other large society, but in a different part of the country each year. As the name implies, the American Federation for Clinical Research is meant to be a *national* organization and as such the meeting should be placed at some time within the reach of all. By thus having the annual meeting in different parts of the country each year, the meeting will come near enough for the members in a given section of the country to attend. Holding the meeting in conjunction with another large society affords the opportunity for making the cost of the trip even more worth-while by being able to attend two society meetings.

The second feature, and I believe unique for this society, consists in the organization of "local research clubs." Such clubs may be organized in any community by any interested group of investigators. The jurisdiction of such a club lies with itself and is not under the American Federation. But it is hoped that members of the American Federation will make themselves responsible for the organization of such "research clubs" and be the sustaining force, interesting the younger members of such groups to work toward membership in the American Federation. Individual members of such local research clubs may attain individual membership in the American Federation for Clinical Research, but local clubs as groups are not to be admitted "en masse" to the federation. Each local club is to be a unit unto itself, organizing and directing its own policies, admitting and limiting its members according to its own desires.

Such clubs are to hold meetings for the presentation of scientific investigation when and where the local club wishes. Intra-city and inter-city meetings between such local research clubs are to be promoted at frequent intervals for the exchange of ideas. Such meetings, held at frequent intervals, maintain and stimulate investigation and will help to take the place of the annual meeting in those years in which one can not afford the time or expense to attend the national meeting.

The inclusion of "local research clubs" as an integral part and important function in the organization

of this society seems to be a very timely one. Recently we have been hearing frequently of other large societies who are dispensing with their annual meeting for the duration of the war and who are substituting other means of carrying on their function. With the American Federation for Clinical Research, if it becomes desirable, or even necessary, to eliminate the national meeting for the duration, the local research clubs can and should carry on, to maintain an interest in investigation and to take the place of the annual meeting.

According to the policies of this organization, the dues have been set at the maximal figure of one dollar a year. This is to pay for necessary correspondence in the society and for printing the program of the annual meeting. With an adequately large membership a dollar a year should be sufficient. However, with the work carried out in the formation of this new society our funds have not been adequate. The secretary requires more help, so it becomes necessary to increase temporarily the dues, which were set at $2.00 a year. After the treasury contains adequate funds, and when our national membership becomes large enough, the amount should be reduced to that which is just sufficient to carry on the necessary program.

These then are the simple principles upon which the American Federation for Clinical Research is founded and upon which it must prosper. I know that numbers of members can not be here to-day because of military service, and undoubtedly we will be hampered in our growth and activity during the period of this war. But prosper it will, if these simple principles are adhered to rigidly. That there is a definite place for such a society as ours is attested by the fact that it has met with a great deal of enthusiasm and by the fact that other societies have started out along somewhat similar lines, but in the course of time have made themselves complicated and out of reach of the majority. Furthermore, in complicating their organization some of the other societies have lost sight of what they set out to do, namely, to stimulate interest in and to give a place to those who are beginning in medical research. Let us hope that the American Federation will always abide by these principles and remain a society whose prime purpose is the stimulation of investigation among the younger members of our profession.

RESEARCH LABORATORIES IN INDUSTRIES[1]

By Dr. O. E. BUCKLEY
PRESIDENT, BELL TELEPHONE LABORATORIES, INC.

INDUSTRIAL research is my own line of work, so perhaps I can best illustrate it and tell how it has grown by choosing an example from the field with which I am connected, that is, telephony.

There is scarcely any feature of telephony that has not been the subject of research in Bell Telephone Laboratories. Take, for example, the telephone receiver that you hold to your ear when you use the telephone. It is just one of a large number of devices that work together to make up the complex telephone system of to-day. It is a little thing, about the size of a watch, and very simple in construction, but there are embodied in it many great scientific achievements.

The present telephone receiver is a direct descendant of the original telephone invented by Alexander Graham Bell. Bell wound some insulated wire around an iron bar, mounted an iron reed close to the end of the bar and so made the first telephone receiver to convert electric currents into sound waves. You will find these same basic elements in the telephone receiver of to-day. The iron bar has evolved into two pieces of permalloy welded to two pieces of remalloy. Permalloy is an alloy of iron and nickel very easily magnetized. Remalloy is an alloy of iron, cobalt and molybdenum, which makes a good permanent magnet. The iron reed has become a diaphragm of iron, cobalt and vanadium which has other desirable magnetic properties. These are only three of the fourteen special materials which go into the modern telephone receiver. Each of these materials is the product of painstaking investigation, not just testing to select the best materials from those available, but research to discover all the hidden factors that determine behavior. The shapes and dimensions of the parts of the receivers are as important as their composition. Simple though the structure is, the design of the telephone receiver called for intricate mathematical analysis, and to test its performance required the devising of new methods of measurement. There even went into its development a study of the nature of speech and an understanding of the physiology of the ear.

Bell was a researcher as well as an inventor when he devised the telephone. He was then studying the nature of speech. He was, if you please, carrying on a kind of industrial research, but of a very different pattern from that of to-day. Bell himself had a good working knowledge of the essential science of his

[1] World-wide broadcast of the American Philosophical Society and WRUL, Philadelphia, July 10, 1942.

time. Now, the bounds of science have extended so far that specialists in many fields—acoustics, magnetics, metallurgy, mathematics, chemistry and even physiology—work together to perfect the instrument which Bell invented almost single-handed.

Bell worked with one assistant in an attic room. To-day, Bell Telephone Laboratories, in great buildings, employs 2,000 engineers, physicists and chemists, plus as many assistants doing drafting, mechanical and other service work, to advance the art of electrical communication that has grown from the original inventions of telegraph and telephone.

We have gone from the era of the individual inventor to the era of industrial research. All the mechanical marvels which have revolutionized our lives—the electric light, the automobile, the airplane, talking pictures, radio broadcasting—as you know them to-day are products of industrial research. They are not inventions, not just bright ideas, though they may have got their start as such. They have evolved from painstaking, deep-searching, scientific endeavor.

This applied scientific endeavor is what we call industrial research. It has been brought about by drawing into industry men of inquiring and capable minds versed in the latest discoveries of physical science and trained in the art of uncovering new scientific knowledge. Among them are those who call themselves physicists, chemists and engineers, but they are more than ordinary ones. They are the practical-minded explorers in those fields who can work in teams and aid one another in their efforts. These groups of industrial research workers are mostly to be found in the research departments of industrial corporations, large and small. In some cases, groups of corporations have joined together in trade associations to support industrial research laboratories. In some cases, groups are supported and operated by the government. Some of these groups deal only with immediate practical problems; and some devote part of their efforts to penetrating the very frontiers of science, uncovering new knowledge so that it may later be practically applied.

In the United States, where industrial research has had its greatest growth, there are more than 2,000 industrial research laboratories employing over 70,000 trained workers. Research laboratories are now maintained in nearly all industrial fields, and there are many new industries which got their start in the research laboratory. Truly, industrial research has become one of the major forces in American industry.

This development of industrial research has occurred in a very brief period of time. Almost all the industrial laboratories in the United States were founded after 1900, and most of them within the past two decades. During this period their growth has been at an astounding rate. Its effects on industrial practices and products have been revolutionary.

What are the factors that have made this change in the industrial picture? There are two that seem to me to stand out. They are: the ever-expanding stock of scientific knowledge and the increasing supply of scientific workers.

Prior to 1900, scientific research was conducted almost wholly in universities and chiefly as a part-time activity by teachers of science whose efforts were primarily to increase scientific knowledge so as to gain a better understanding of the workings of nature without particular regard to applying the results of their research to practical needs. New devices in industry were largely the result of individual inventive effort. The independent inventor could carry in his own mind all the world's knowledge in his particular field. Bell was fully versed in the acoustics of his day, as well as in electricity and magnetism. Edison was well versed not only in the electricity and magnetism of his day, but in chemistry as well, though he had only elementary schooling.

To-day the range of scientific knowledge is so wide that no one person can comprehend thoroughly a very wide sector of it. There is no such person as an up-to-date general chemist. There are physical chemists, organic chemists, electro-chemists and other kinds of chemists. Similarly, there are varieties of physicists and engineers. Indeed, on the frontiers of science one can know only a very small sector. Hence, to make practical advances in the complex mechanisms that we deal with to-day, we must put together intelligently knowledge from many fields of science, and this requires that scientists from all these fields pool their knowledge and combine their efforts.

Scientists are drawn by the industrial laboratories from the graduate schools of our great universities and, as I said, the supply of these scientists has been one of the major factors in the development of industrial research.

In the preceding era, that of invention, the supply of new scientists was scarcely adequate to meet the demand for teachers of science. Even up to 1920 in the United States, universities and colleges absorbed for teaching purposes nearly all their output of manpower trained in and adapted for scientific research. A few industries were wise enough to see the need for applying to their own problems the methods of inquiry of the science departments of the universities. They employed a few outstanding university scientists, and as the supply of students became more than large enough to fill educational demands, young scientists were drawn into employment in industry. Those who made themselves effective there stimulated the demand for more, and soon made the opportunity in industrial

research quite as attractive as that in academic research. Thus came about the rapid expansion of industrial research of the last few years. This is a movement which we can expect to see repeated in many parts of the world where industrial research is still at an earlier phase of evolution.

This influence of the availability of scientists is interestingly illustrated in the chemical industry in Germany. In the early nineteen-hundreds the German universities turned out many more trained chemists than could find employment in teaching. These sought employment in industry, where great numbers were put to work in organized industrial research. The results of their efforts contributed to the tremendous technical advantage of Germany prior to the first World War, particularly in the field of organic chemistry. Since then the tables have turned, and the advantage in industrial research even in this special line is no longer with Germany. Nazi domination has stultified her science and has diverted its aims to the destruction of man rather than to his welfare. She has forced the rest of us to divert our aims in industrial research to her own destruction.

To-day, our great laboratories are engaged almost wholly in devising tools to destroy the anti-social, anti-scientific forces that threaten to stop the progress of scientific endeavor throughout the world.

When that task is done, industrial research will revert to its peaceful pursuits. As education in science expands, more workers in more lands will join the ranks of explorers who are widening the bounds of human knowledge. A new and larger crop of young scientists will bring forth the products on which new industries will be built. The welfare of all will be advanced to the detriment of none. Science demands a free world, and the workers in science will win it.

OBITUARY

FRANCIS RAMALEY

FRANCIS RAMALEY came to the University of Colorado in January, 1898. In his death on June 10, 1942, his adopted university, community and state lost one who had for forty-four years given unselfish service and loyalty. He left a permanent impression for good on the organizations with which he was associated, and his fine personal qualities will always be remembered by those who knew him.

Francis Ramaley was born at St. Paul, Minnesota, on November 16, 1870. He received his bachelor's and master's degrees from the University of Minnesota in 1895 and 1896. From 1895 until 1898, when called to the University of Colorado as assistant professor of biology, he was instructor in botany at the University of Minnesota. He received his Ph.D. degree from the University of Minnesota in 1899. In April, 1900, following the resignation through ill health of Professor John Gardiner, his predecessor at the University of Colorado, he was appointed professor of biology. From that time until his retirement in 1939 he was responsible for the administration of the department of biology.

Among other responsibilities which Professor Ramaley assumed during this period were those of acting president of the university in 1902, acting dean of the College of Pharmacy from 1917 to 1919, and acting dean of the Graduate School in 1929 and again from 1932 to 1934. He was editor of the University of Colorado Studies from its establishment in 1902 until his final illness this year, this appointment having been continued after his retirement from regular teaching duties. He was secretary of the Arts and Sciences Faculty for twenty years, and was a member of many important committees, some of which were extremely important factors in shaping the development of the university. In large part through his influence, chapters of Phi Beta Kappa and Sigma Xi were organized at Colorado at a time when the institution was still relatively small, the years of establishment of these chapters being 1904 and 1905, respectively. His good judgment was valued by his colleagues in both administration and teaching. Through a natural reserve he was averse to giving advice and help when it was not requested, but those who knew him best did not hesitate to ask for it. His advice was valued not only for its inherent worth but for the spirit of generosity with which it was invariably accompanied. Professor Ramaley never made one feel that he begrudged the time devoted to helping others.

In the classroom Professor Ramaley's lectures were marked by careful organization and perfect clarity. He maintained high standards of achievement and thoroughness, but presented the subject-matter in such a way that the most difficult aspects seemed simple. In spite of other responsibilities, he always assigned himself an average or above average teaching load. Nor was this delegated to others. He even graded his own quiz and examination papers. This was but part of his effort to treat students with complete justice. A few of his advanced students and colleagues have had the rare opportunity of extended field trips with Professor Ramaley. It was on such occasions that his qualities of good humor, patience and friendliness were much in evidence. I shall always look back with pleasure to a week in the San Luis Valley with Pro-

fessor Ramaley in the summer of 1931, my introduction to southern Colorado. It could not have been with a better guide.

Professor Ramaley's research, in which he persisted in spite of the demands of his position, was primarily in the field of plant ecology. Instruction in plant ecology was introduced by him at the University of Colorado as early as 1899. He was a pioneer in montane plant ecology. During his first years at Boulder he spent much time in the mountains, publishing many papers on the results of his studies on plant distribution in the Colorado Rockies. This interest was a factor in his establishment in 1909 of the University of Colorado Mountain Laboratory, at Tolland, Colorado, one of the first inland biological stations in America, which he directed until 1919. For many years he was interested in sandhill vegetation, one of his most extensive recent papers being "Sandhill Vegetation of Northeastern Colorado," published in 1939 in Ecological Monographs. His last published work was an extensive report on the "Vegetation of the San Luis Valley in Southern Colorado," which appeared in the University of Colorado Studies while he was confined to the hospital in his last illness. This was based on observations made during many trips to the valley during the past twelve to fourteen years. It was characteristic of his personal generosity that this paper was published "without expense to the University."

In addition to some seventy papers, primarily in the field of plant ecology, he was the author of several books, the best known being his "Colorado Plant Life" and (with W. W. Robbins) "Plants Useful to Man." His interest in economic botany seems to have been stimulated by his travels in the Orient in 1904. As a result of this trip semi-popular accounts of his observations in Java, Ceylon and Japan appeared in the *Popular Science Monthly*.

From the time of its organization, Professor Ramaley was active in the Ecological Society of America. In 1931 he was vice-president, and in 1940 president. During the last two years of his life he was botanical editor of *Ecology*. He was an active member of several other scientific organizations as well, including the American Association for the Advancement of Science (president of the Southwestern Division, 1930), American Society of Naturalists, Botanical Society of America, Limnological Society, Society for Experimental Biology and Medicine and the Colorado-Wyoming Academy of Science.

Associates in the community, while not always aware of Professor Ramaley's scientific or academic achievements, knew him in other connections, for he was active in community affairs. For many years he was a member of the Boulder school board. He attended services regularly at the First Congregational Church, Boulder, and served many years as a member of its board of trustees. He gave both time and financial support to all enterprises that made for a better community, for his family, his colleagues and his students.

Professor Ramaley is survived by his wife, Ethel Jackson Ramaley, and four sons.

GORDON ALEXANDER

UNIVERSITY OF COLORADO

LAURENCE S. MOYER

ON June 8 of this year, Dr. Laurence S. Moyer, professor of botany at the University of Minnesota, was killed while serving his country. The accident which caused his death was the collision of two blimps off the coast of New Jersey.

Dr. Moyer was a native of Norristown, Pennsylvania, and a graduate of the University of Pennsylvania. He was but thirty-five years of age. When brilliant men are taken early in life, one wonders where plan or purpose enters into this world of ours. Dr. Moyer was endowed with a strong character, a keen and analytical mind and a reserved but gracious manner.

While a student in a course on methods of research on protoplasm, he selected electrophoresis as a technique which promised much. His first work in this field proved the wisdom of his decision. He made use of the rate of electrophoretic migration as a means of classifying species. By analyzing mobility curves and grouping isoelectric points of latex particles from Euphorbias, Moyer was able to taxonomically classify the species of this genus. He thus had the pleasure of being the first to show that plant relationships when determined by a single physical property of the plant proteins fully agree with the morphological, chromosomal and geographical characters of the species.

Dr. Moyer soon turned his attention to the electrophoretic properties of proteins in general. In collaboration with his wife and Dr. Harold A. Abramson, he made many noteworthy contributions to protein chemistry. At the time of his death he had completed a volume on the properties of proteins ascertained by electrophoresis. The work was done jointly with Drs. Abramson and Gorin. For some time to come this book will remain the final authority on the subject.

Dr. Moyer is not to be judged solely by his research ability and his experimental findings. Equally great were his powers of interpretation, and equally fine his relationships with his fellow men. These adjuncts are as necessary to a complete fulfilment of a scientist's place in society as are his experiments. The mere collecting of data is futile if the findings are not applied, correlated and given thought; in short,

the seeker of more knowledge is of little value to mankind if he does not take a sympathetic part in cooperative work. Dr. Moyer possessed these qualities to an extraordinary degree. He was a happy participant in symposia, ever ready for constructive discussions, never allowing a controversy to degenerate into a polemic. He was always friendly, and, though never austere, maintained a dignity which made one appreciate the presence of a scholar of innate refinement. Had he lived, we should have known more.

WILLIAM SEIFRIZ

UNIVERSITY OF PENNSYLVANIA

LAWRENCE TWILLEY CLARK

DR. LAWRENCE TWILLEY CLARK, managing director of the Research and Biological Laboratories of Parke, Davis and Company, died on May 29, at the age of sixty-one years. His entire scientific career was spent in the services of the company, having begun when he entered as a research worker in bacteriology soon after receiving his bachelor of science degree from the Michigan State College in 1904. His rise to the position of managing director of the laboratories and of the biological farm paralleled the rapid expansion of the research activities of the company. His contribution to the standardization of biological manufacturing methods, especially in the field of bacterial products, was perhaps his most outstanding achievement, recognized by his alma mater in 1932 with the honorary degree of doctor of science.

Dr. Clark was a member of many scientific organizations and was active also in the alumni association of his college, which elected him president in 1932. His hobbies were all associated with his devotion to the out-of-doors—hunting, fishing and fruit farming. He is survived by his widow, Rosa, and by his son, Lawrence Twilley, Jr.

OLIVER KAMM

RECENT DEATHS

DR. HENRY F. NACHTRIEB, professor emeritus of animal biology at the University of Minnesota, died at his home in Berkeley, Calif., on July 17. He was in his eighty-sixth year.

DR. ONDESS LAMAR INMAN, director of the Charles F. Kettering Foundation and professor of biology of Antioch College, died on July 21 at the age of fifty-one years.

PROFESSOR HOWARD M. WIGHT, professor of forest zoology at the University of Michigan, died on July 19. He was fifty-three years old.

NORMAN COLMAN RIGGS, professor emeritus of mechanics at the Carnegie Institute of Technology, Pittsburgh, where he had been a member of the faculty for over thirty years, died on July 18 at the age of seventy-one years.

PROFESSOR SCOTT CARY LYON, for sixteen years head of the department of biology at Davidson College, North Carolina, died on July 23 at the age of fifty-eight years.

DR. CHARLES R. HOOVER, formerly professor of chemistry at Wesleyan University, died in the collision of two Navy training blimps off the coast of Manasquan, N. J., on June 8. SCIENCE has already reported the death in the same accident of Dr. Laurence S. Moyer, of the University of Minnesota, an obituary of whom appears in this issue, and of Dr. Arthur B. Wyse, assistant astronomer at Lick Observatory.

BRIGADIER GENERAL H. S. BIRKETT, from 1894 until his retirement with the title of emeritus in 1932 professor of laryngology and otology in the faculty of medicine of McGill University and from 1914 to 1924 dean, died on July 19. He was seventy-eight years old.

A UNITED PRESS dispatch from Vichy reports the death on July 19 of Professor Marcellin Boule, a member of the faculty of geology at Clermont-Ferrand and a professor of paleontology at the Museum of Natural History. He was seventy-two years old.

SCIENTIFIC EVENTS

PRESENT STATUS OF RESEARCH WORK UNDER THE AUSPICES OF THE WAR PRODUCTION BOARD

(1) In July, 1940, the National Defense Commission made a contract with the National Academy of Sciences (of which the National Research Council is a subsidiary) for the establishment of technological committees to report to the National Defense Commission. This contract was renewed and enlarged by the Office of Production Management and by the War Production Board. In the earlier stages the work of the technological committees was confined to the mobilization of existing technical knowledge on particular questions. Recently the scope has been enlarged to include actual laboratory work, and is capable of further expansion to any desired degree. Up to date 143 reports have been requested of the academy and 124 reports received by the War Production Board. Of the 143 projects submitted, 82 relate to processes and production. A very large amount of

construction has been based on this group of reports. Sixty-one of the reports relate to substitution and conservation and this group has served as a basis of many substitution and conservation orders of the War Production Board.

Reports of general interest which are not secret or confidential have been mimeographed for general distribution and copies may be obtained from Ernst Hergenroether, Room 3116, Railroad Retirement Building, Washington, D. C. The academy assumes the responsibility of selecting the members of the technological committees both from within and without its own membership. C. K. Leith, of the University of Wisconsin, acts as the agent of the War Production Board for the transmission of requests to the academy.

(2) The War Production Board has made extensive use of the services of the Bureau of Mines and the Geological Survey. In fact, it has helped in securing extra funds from Congress for this purpose and has advised on a large part of the work of these two organizations in the field and laboratory since 1940.

(3) The War Production Board has used the Bureau of Standards for research and testing on several commodities.

(4) The branches of the War Production Board have instigated and utilized researches in many industrial laboratories. For instance, the Bureau of Industrial Conservation has used the research facilities of the American Bell Telephone Company, General Motors, Westinghouse, General Electric, Chrysler, the Battelle Institute, the Mellon Institute, the California Institute of Technology and others.

(5) The Inventors Council transmits to the War Production Board such reports of inventions as it thinks should have further attention. These go to Ernst Hergenroether, Bureau of Industrial Conservation, who passes them on the branches of the War Production Board concerned. Two new specialists are being appointed to help in this work.

In all the work above outlined, the principal object has been to mobilize existing technical information in the least possible time, and to do only such laboratory work as would yield results in time to be used in the war emergency. This necessarily has eliminated many researches which would be highly desirable from a longer range point of view.

The following additional steps are now being taken:

(1) A review is being made of the activities of divisions and branches of the War Production Board to make sure they are utilizing to best advantage all available opportunities for research. With the creation of new divisions and the turnover in personnel, we believe that even the existing facilities for research in some branches are not being fully utilized. Instances have come to our attention where there seemed to be no knowledge of the existing facilities.

(2) An effort is being made to improve the dissemination of the research reports through the various parts of the War Production Board, to insure wider publicity and to follow up the recommendations of these reports to see that they are actually used in the various administrative activities of the War Production Board.

(3) To make wider use of research facilities in the United States not now engaged in the war effort, the War Production Board has requested the National Research Council to appoint a committee to make recommendations to the board as to the most effective grouping of research facilities, by regions or by adaptation to classes of projects; as to desirable form of organization of these groups; and as to procedure to establish a two-way flow of ideas and projects between the War Production Board and the research groups that may be set up.

SYNTHETIC RUBBER

IT is stated in the *National Geographic News Bulletin* that as a center of synthetic rubber production, Voronezh, Russia, "anchor" of the northern Don front, is of special interest to Americans now concerned with their own manufacture of this material.

Voronezh normally is one of the Soviet Union's leading sources of rubber made from alcohol that has been processed from potatoes. Other important sources of this type of rubber are still out of range of immediate German attack; for example, Yaroslavl, northeast of Moscow, and Kazan, some 500 miles northeast of Voronezh.

Before the outbreak of the war, Soviet authorities claimed that their country was the world's largest producer of artificial or synthetic rubber. Moreover, its high quality was demonstrated as far back as 1933, when tires of such rubber were used in the extensive motor races across the Kara Kum Desert, in Central Asia.

With its expanding rubber and other industries, Voronezh was one of the fastest growing of Soviet Russia's industrial centers. In 1926, the city had a population of less than 125,000; by 1939, it had passed the 326,000 mark, including nearly 90,000 workers in factories and locomotive and other repair shops. It had a dozen colleges and universities, in which some ten thousand students were reported in training for the chemical, engineering, teaching and medical professions, as well as for agricultural and veterinarian work.

In addition to synthetic rubber, Voronezh specialized in manufactured food products, in vegetable oil from sunflower seeds, in turning out radio equipment, Diesel engines, tractor parts, machinery and machine tools. Like other rising industrial towns of the region, it drew fuel and raw materials from the rich coal and

iron deposits of the Don basin and from the fertile fields of the surrounding country of the central Black Soil area.

THE NATIONAL REGISTRY OF RARE CHEMICALS AT THE ARMOUR RESEARCH FOUNDATION

IN principle, the Registry of Rare Chemicals consists of a central file of information, through which a scientific worker can learn the location of a small or large amount of some urgently needed rare chemical.

1. Only chemicals not listed in the commonly available catalogues should be considered rare chemicals. However, newly developed chemicals should be reported as soon as possible even if cataloguing in the near future is anticipated. Small amounts on hand are important.

2. Information received on sources of chemicals will be filed. If a chemical is known under more than one name, this information will be helpful in identifying the compound when a request for it is received by the registry. Wherever possible the amount available should be given. In special cases, where individuals or organizations, for reasons of policy, wish to remain anonymous as sources of certain rare chemicals, the registry agrees to transmit actual chemicals without revealing the identity of the source.

3. Replies to requests for sources of chemicals will be made on post cards with attached return card. The return card serves the twofold purpose of acknowledging receipt of the information, and submitting data on new chemicals which may have become available. Telegraphic requests will be answered by wire collect.

4. If the registry inadvertently omits a source of chemicals when several are known, this oversight should not be interpreted as an expression of preference. Since the registry does not handle chemicals except as stated under (2) above, arrangements for any financial compensation for chemicals must be made between the owner and recipient of such chemicals.

THE PUBLIC HEALTH RESEARCH INSTITUTE OF THE CITY OF NEW YORK

IT is stated in the *Journal* of the American Medical Association that the Public Health Institute of the City of New York., Inc., will receive $100,000 a year for ten years for its researches on public health. The city and the institute, a non-profit scientific institution, have entered into a contract which went into effect on July 1 and is automatically renewable for similar periods of ten years unless previously abrogated. The money is to be used by the institute to carry on fundamental medical research by a staff of competent investigators under the direction of a research council composed of authorities in the fields of medicine, biology, physiology, nutrition, public health and related fields. The contract was signed after the legislature passed a bill authorizing cities to enter into such contracts with non-profit scientific institutions to carry on "research into matters pertaining to public health." Under the contract, the services to be rendered by the institute include the following:

Research and investigation into the control of diseases such as influenza, poliomyelitis, arthritis, degenerative diseases and general physiologic problems such as nutrition.

Generally to engage in laboratory experimentation and research in order to develop better and more economical biological products and improved technical procedures for use in combating diseases and epidemics.

To aid and assist the director of the bureau of laboratories of the department of health in matters involving public health research.

The city, on its part, agrees "to permit the institute to use and to make available for such use part of the premises now occupied by the bureau of laboratories of the department of health at the William Hallock Park Laboratory, or any other building or premises owned, leased or controlled by the city suitable or proper for laboratory investigation and research, during the term of this agreement or its renewal, without any charge for rent, water, heat, light, janitorial services and maintenance. The annual payments of $100,000 for the ten-year period will be paid in quarter annual payments each year. The results of the institute's research "shall be the property of the city." Any discoveries of products or methods shall belong to the city as soon as made, for which there shall be no compensation. All patents issued to the city or to any of its employees shall be assigned immediately to the city, for which there shall be no compensation. David M. Heyman is president of the board of directors of the institute. Other members include the mayor, the controller, Health Commissioner John L. Rice; David Rockefeller, *vice-president;* Edwin F. Chinlund, *treasurer,* and David Morse, *secretary.* The research council, in charge of all scientific programs, will be directed by Dr. Thomas M. Rivers, of the Rockefeller Hospital. Other members are Dr. Eugene L. Opie, Dr. Henry L. Sherman, Dr. George Baehr, Dr. Michael Heidelberger and Dr. Ralph S. Muckenfuss, director of the bureau of laboratories.

SYMPOSIUM ON POTASH AT THE BUFFALO MEETING OF THE AMERICAN CHEMICAL SOCIETY

AGRICULTURAL authorities of the United States and the Hawaiian Islands will make addresses in a symposium on "Potash" at the one hundred and fourth national meeting of the American Chemical Society to be held in Buffalo from September 7 to 11. It will be sponsored by the Division of Fertilizer Chemistry, of which Dr. H. B. Siems, of Swift and Company, Chicago, is chairman.

Dr. G. R. Mansfield, of the U. S. Geological Survey, will open the symposium with a discussion of Ameri-

can potash deposits and reserves. Great reserves of unrefined run-of-mine salts, readily available, will more than equal any deficit in the refined salts that may develop. The wartime contribution of the American potash industry will be described by Dr. John W. Turrentine, of Washington, D. C., president of the American Potash Institute, who has been appointed chairman of the symposium. Twelve other scientific papers to be presented will deal with soil reactions and trace potassium through its many chemical and biological functions from the soil solution to the harvested crop. These reports will discuss important crops as experimental material. Dr. H. L. Garrard, senior field agronomist of the American Potash Institute, will close the program with a motion picture in color of "Potash Production in America," showing the potash mines and refineries of New Mexico and California.

According to a statement made by Dr. Turrentine, the outstanding wartime contribution of the potash industry is to make possible the great expansion in certain specified lines of agricultural production called for by the government—the "production goals." Foremost is food for Americans, now in a position to enjoy three full meals a day, because of their full-time, lucrative employment. Superimposed is food for the United Nations, to be expanded to include food for the peoples of occupied countries now devastated by invading tyrants, to be supplied when freed from their oppressors.

Included are food crops susceptible of preserving and concentrating, horticultural crops grown intensively which if produced profitably must be scientifically fertilized. Meat and dairy products are emphasized which if produced with optimum efficiency call for high quality, nutritive herbage—legumes and grasses—which can best be grown on properly fertilized fields and pastures.

The major use of potash is as a plant food, essential to profitable agriculture and for which there is no substitute. It is to this fact that it owes its commercial and social importance. Approximately 90 per cent. of the potash here produced is so used, most of it reaching the consumer, the farmer, as a constituent of commercial fertilizers in ratios with other plant foods recommended by agronomists—recommendations based on experimental evidence of what is most profitable for specific crops growing on specific soil types.

In the chemical field, the wartime contribution of potash to national independence, security and comfort likewise has been marked with outstanding success. These chemicals and their derivatives enter into innumerable peacetime applications and every-day usage. Chlorates, for example, are essential constituents of the modern match. Expansion in production to supply these normal, peacetime requirements has had to be further increased to provide for military requirements. Many potassium compounds are officially listed as of military importance.

SCIENTIFIC NOTES AND NEWS

DR. ALFRED N. RICHARDS, professor of pharmacology at the University of Pennsylvania, has been elected a foreign member of the Royal Society of London. Other foreign associates elected are Dr. L. Ruzicka, professor of organic chemistry in the Federal Technical College, Zurich; Dr. N. V. Vavilov, of Leningrad and Moscow, and Professor I. M. Vinogradov, of Moscow.

THE Heberden Society has awarded the Heberden Medal for research in rheumatic diseases for 1942 to Dr. Philip S. Hench, of the Mayo Clinic, Rochester, Minnesota, "in recognition of his distinguished contributions to the subject over a number of years, and particularly of his most recent work on the effect of jaundice on the course of rheumatoid arthritis."

DR. RAY LYMAN WILBUR will continue as chancellor of Stanford University through the academic year of 1942–43 at the request of the board of trustees because of the war emergency. Dr. Wilbur reached Stanford's retirement age in 1940, but was asked to stay on through 1941, the fiftieth anniversary year of Stanford and the twenty-fifth year of his presidency. This is the third extension of tenure since Dr. Wilbur's retirement.

ON the retirement of Dr. Reginald A. Daly from the Sturgis-Hooper research professorship of geology at Harvard University, he will be succeeded by Dr. L. C. Graton, since 1912 professor of mining geology.

DR. W. N. LOWRY, professor of physics at Bucknell University, has been appointed chairman of the department, of which he has been a member for twenty years.

AT the Michigan College of Mining and Technology, Harry E. Krumlauf, mining engineering; Dr. R. F. Makens, chemistry, and E. P. Wiedenhoefer, civil engineering, have been promoted to associate professorships, and Russell J. Smith has been made assistant professor of metallurgical engineering.

DR. MAX EDWIN BRITTON, instructor in the department of botany of Northwestern University, has been promoted to an assistant professorship.

DR. HENRY T. HEALD, president of the Illinois Institute of Technology, has been elected president of the Society for the Promotion of Engineering Education.

THE International Nickel Company, Inc., New York, N. Y., has resumed work at Mellon Institute of Industrial Research, Pittsburgh, by the establishment of an industrial fellowship. Dr. John Gilbert Dean, a physico-organic chemist, is the incumbent of this fellowship. There has also been established a multiple fellowship on chemical containers and storage by the Pittsburgh-Des Moines Steel Company. The senior incumbent of this fellowship is Dr. James Bert Garner, who is known professionally for his achievements in hydrocarbon chemistry and technology. He is aided by Ludwig Adams, a specialist in engineering materials and welding, and by R. M. Stuchell, a research metallurgist.

DR. FRANK A. CALDERONE has been appointed secretary of the New York City Department of Health, to succeed Goodhue Livingston, Jr., who has resigned for war duty. Dr. Calderone is a member of the faculty of New York University and has been since 1938 district health officer of the lower East Side.

DR. MERRILL K. BENNETT, economist and executive secretary of the Stanford University Food Research Institute, has been named executive director of the institute and will assume its general leadership. Dr. Joseph S. Davis will continue as a director with special responsibility for the research project on international commodity agreements for which the Rockefeller Foundation made a grant of $40,000 two years ago.

ACCORDING to *Chemical and Engineering News*, additions to the staff of the Chemical Engineering Section of the Armour Research Foundation, Chicago, are John M. MacGregor, of the Division of Soils, University of Minnesota; Ibert Mellan, author of "Industrial Solvents" and "Organic Reagents in Inorganic Analysis"; E. L. Hill, recently head of the department of chemistry of Carthage College; and Francis J. Frere, of the Standard Oil Development Company, Elizabeth, N. J. Dr. Frere will direct the analytical laboratory of the foundation.

DR. WILLIAM H. MARTIN, dean of the College of Agriculture of Rutgers University and director of the New Jersey Agricultural Experiment Station, has been appointed consultant on agricultural chemicals to the War Production Board on a part-time basis.

THE *Journal* of the American Medical Association reports that Dr. Donald B. Armstrong, third vice-president of the Metropolitan Life Insurance Company, New York, in charge of health and welfare work of policy-holders, has been appointed a senior surgeon in the reserve corps of the U. S. Public Health Service. Dr. Armstrong's appointment to the public health service reserve is on a basis of inactive status, without compensation, barring major emergencies calling for additional aid of physicians with public health training. For the time being, he is assigned to his present task in connection with the public health, nursing, educational and medical research activities of the Metropolitan's welfare division.

GEORGE I. QUIMBY, JR., formerly director of the Muskegon County Museum, Michigan, has received a temporary appointment as assistant curator of North American archeology and ethnology at Field Museum of Natural History, Chicago. Mr. Quimby will serve during the absence on war service of Dr. Alexander Spoehr, the regular curator. Dr. Spoehr, who for some months past has been an army corporal, has been transferred to the navy in which he will receive a commission as ensign.

Chemical and Engineering News states that Lieutenant Colonel C. E. Watts, formerly of the research staff of the Commercial Solvents Corporation, Terre Haute, Ind., has been promoted from the grade of major. He is on duty in the Ammunition Division, Office of the Chief of Ordnance, Washington, D. C.

THE Civil Service Commission is seeking hundreds of physicists to work with specific war problems in the general field of physics. Physicists are being recruited for the Federal Government under a new examination announcement. To qualify, applicants must have a college degree with major study in physics or closely allied subjects. They must also have had a minimum of two years of professional experience in the field of physics or appropriate graduate study in this field or a combination of the two. The amount and character of the experience required beyond this minimum will vary with the grade and salary of the position for which the applicant is considered. Under this new announcement, teaching of physics will be considered professional experience for any of the grades of positions. Those who received eligible ratings under the physicists examination announced in March of this year need not apply unless they now possess the qualifications for eligibility for a higher grade position. The new examination announcement and application forms may be obtained at any first- or second-class postoffice or from the commission in Washington, D. C. Applications will be accepted until the needs of the service have been met.

THE convention of the Electrochemical Society will be held at Detroit from October 7 to 10, under the presidency of Edwin M. Baker, consulting engineer, professor of chemical engineering at the University of Michigan.

THE American Coordinating Committee on Corrosion is composed of representatives of twenty-four national, scientific and technical societies and research organizations. Dr. R. M. Burns is chairman, and Dr. R. B. Mears, assistant chemical director of the Bell Telephone Laboratories, has been appointed vice-chairman. The committee meets once a year at Gibson Island, Maryland. The next meeting will be held from August 3 to 7 under the auspices of the American Association for the Advancement of Science.

EIGHT articles on the cytology of the protozoa, translated from the German, by the personnel of the Work Projects Administration, and technically edited by the late Dr. John P. Turner, of the University of Minnesota, are filed in the American Documentation Institute, 2101 Constitution Avenue, Washington, D. C.

THE Arnold Arboretum of Harvard University issued the first number of a new periodical, *Sargentia*, on July 20. This periodical is a continuation of the Contributions from the Arnold Arboretum (1932–38) and is named in honor of Charles Sprague Sargent, first director of the Arnold Arboretum. The first number contains a foreword by Dr. E. D. Merrill and a 148-page treatment, by A. C. Smith and several collaborators, of the Fijian plants collected on the 1940–41 Pacific Cruise of the "Cheng Ho," sponsored by Mrs. Anne Archbold. In this paper ninety-one new species and several varieties are described, while numerous other new names are proposed and several genera are treated in detail for the region. It is planned to publish *Sargentia* at irregular intervals, presenting longer papers in various botanical fields. The second number, a study of the Chinese Araliaceae, by Hui-Lin Li, will be distributed in September or October. Subscriptions and requests for information should be addressed to The Librarian, Arnold Arboretum, Jamaica Plain, Mass.

THE *Journal* of the American Medical Association reports that the Columbia Foundation, San Francisco, has given $20,000 to finance a research project in ophthalmology at the Mount Zion Hospital Research Laboratories, San Francisco, under the direction of Drs. Frank H. Rodin and Charles Weiss. The work will include a study of bacteriology and immunology of the eye. First it is planned to study the flora of the normal eye and of the common eye diseases. Later the study of special problems will be undertaken. The Columbia Foundation was established in 1940 in the interest of educational, cultural and philanthropic activities, internationally.

Nature states that the trustees of the late Sir Henry Wellcome have placed a sum of up to £20,000 at the disposal of the Medical Research Council for research into methods of drying blood-plasma and blood-serum to provide stable products for use in transfusion. The gift is to be applied to the purchase, erection and operation by the council of a plant which will make it possible to test and develop these methods on a substantial scale, and the products will be freely available for the treatment of sick and wounded at home, at sea and abroad.

THE General Aniline and Film Corporation has leased a four-story building in South Easton, Pa., which will be remodeled for use as a central research laboratory. The leased building is a reinforced concrete structure formerly operated as one of the plants of the Stewart Silk Corporation. A number of research men working in the chemical field will be transferred from the operating plants of the company to the new Easton laboratory and their number will be augmented by other chemists. The corporation operates dye-making plants at Grasselli, N. J., and Rensselaer, N. Y. Its plants for the manufacture of photographic apparatus and supplies are at Binghamton and Johnson City, N. Y. Due to its pre-war affiliation with I. G. Farben, the German dye trust, control of the corporation is now vested in Leo T. Crowley, alien property custodian.

ACCORDING to *Nature*, the managers of the Royal Institution have made special arrangements for carrying on the work of the institution under the present conditions. Activities are necessarily somewhat limited by war circumstances, and many members of the staff of the institution itself and of the Davy Faraday Research Laboratory are absent on war service. The laboratories and workshops are, however, fully employed, and a program of lectures has been successfully carried out during the 1941–42 season. The institution has also, with the managers' permission, been the center for various scientific meetings and conferences in connection with war purposes; among them, a course of special lectures, in November and December, 1939, to meet the needs of students wishing to qualify for radio branches of the defense forces; a series of lectures on "The Nation's Larder," in April and May, 1940, arranged with the approval and support of the Ministry of Food; and in September, 1941, the Conference on Science and World Order, held by the Division for the Social and International Relations of Science of the British Association. It is hoped to maintain and perhaps extend these activities. As a temporary measure, pending the appointment of a successor to Sir William Bragg, the managers have made the following appointments: The general secretary, Thomas Martin, on leave of absence with the Ministry of Supply, to be "resident" in charge of the house; R. Cory, librarian, to be deputy general secretary; Dr. A. Muller, assistant director of the Davy Faraday Research Laboratory, to be acting director.

DISCUSSION

RESEARCH ACTIVITY AND THE QUALITY OF TEACHING IN MEDICAL SCHOOLS[1]

A RECENT study demonstrated a great variation in the degree to which various British and American journals were quoted in the medical sciences.[2] Taking this as a basis, the various medical schools were distributed according to the number of publications in the thirty-six most quoted United States medical journals during the two-year period from March, 1932, to March, 1934 (Table I). Independent hospitals and research institutions were not listed for this study. Harvard and Johns Hopkins were the leaders in 1932 to 1934 with 677 and 454 publications in the most quoted journals. At the other end of the list were three schools with no publications during the two-year period in the thirty-six most quoted journals.

TABLE I

NUMBER OF PAPERS PUBLISHED IN THE 36 MOST QUOTED MEDICAL JOURNALS DURING THE 2-YEAR PERIOD FROM MARCH, 1932, TO MARCH, 1934, DISTRIBUTED ACCORDING TO MEDICAL SCHOOLS (INDEPENDENT HOSPITALS AND RESEARCH FOUNDATIONS NOT LISTED)

1. Harvard	677	38. S. California	26
2. Johns Hopkins	454	39. George Wash.	26
3. Columbia	448	40. Arkansas	26
4. Chicago	421	41. Loyola	25
5. Yale	359	42. Missouri	24
6. California	351	43. Syracuse	24
7. Pennsylvania	334	44. Indiana	22
8. Northwestern	269	45. Georgetown	21
9. Illinois	262	46. Long Island	20
10. Washington	257	47. Temple	20
11. Minnesota	248	48. Tennessee	19
12. Cornell	222	49. Emory	19
13. Michigan	212	50. Oklahoma	18
14. Wisconsin	208	51. Alabama	17
15. Stanford	188	52. Med. Col. Va.	17
16. Western Reserve	187	53. S. Carolina	17
17. New York University	166	54. Louisville	17
18. Rochester	150	55. Albany	15
19. Iowa	140	56. N. Y. Homeop.	15
20. Tulane	106	57. L. S. U.	14
21. Vanderbilt	89	58. West Virginia	14
22. Oregon	60	59. N. Carolina	12
23. Virginia	76	60. Marquette	11
24. Cincinnati	73	61. Baylor	10
25. St. Louis	52	62. Creighton	9
26. Ohio State	49	63. Vermont	8
27. Tufts	49	64. Georgia	7
28. Pittsburgh	46	65. Wayne	7
29. Boston U.	46	66. Utah	4
30. Nebraska	45	67. Howard University	3
31. Buffalo	44	68. Dartmouth	3
32. Duke	39	69. Med. Evan.	2
33. Texas	39	70. Mississippi	2
34. Kansas	38	71. Woman's M. C.	1
35. Jefferson	37	72. Wake Forrest	0
36. Maryland	32	73. Hahnemann	0
37. Colorado	31	74. Meharry	0

It was decided to see if there was any correlation between the research activity in the various schools and the quality of teaching. This latter could of course be estimated by waiting 15 or 20 years and then analyzing the records of the graduates of the various schools. An alternative was to study the state board statistics as published in the various issues of the *Journal* of the American Medical Association. This, it was hoped, would give some estimate of the immediate efficacy of the teaching. It would perhaps not be fair to schools whose faculties are largely research faculties and whose teaching is on a graduate basis. The students of such schools might be expected to do poorly on state board examinations and yet improve in later years due to excellent reading habits usually fostered in such institutions.

MATERIALS AND METHODS

The state board results for all states for 1931, 1932, 1934, 1935 and 1936 (approximately the years covered in the study of research activity) were taken from weekly issues of the *Journal* of the American Medical Association. Several issues for the year 1933 were missing and the year 1936 was substituted. It was found that no states except Massachusetts and New York reported failures over the five-year period for local graduates which exceeded 3 per cent. Consequently, the results for local graduates were eliminated for all states.

TABLE II

THE RELATIONSHIP BETWEEN THE PERCENTAGE OF FAILURES IN STATE BOARD EXAMINATIONS AND THE SCIENTIFIC OUTPUT OF THE FACULTY (15 SCHOOLS WITH 200 OR MORE CANDIDATES IN FOREIGN STATE BOARDS)

	State Boards			Faculty Publications		
	Candidates	Failures	Per cent.	Teachers	Papers	Annual Rate
1. Harvard	276	3	1.1	459	677	74
2. Pennsylvania	354	11	3.1	365	334	45
3. Chicago-Rush	507	18	3.6	504	421	41
4. Northwestern	455	8	1.8	402	269	33
5. Tulane	287	7	2.4	157	106	33
6. Maryland	238	8	3.4	233	32	7
7. George Wash.	266	15	5.6	164	26	8
8. Jefferson	362	21	5.8	248	37	7.5
9. Creighton	244	16	6.6	122	9	4
10. Hahnemann	287	19	6.6	183	2	0.5
11. St. Louis	246	22	8.9	304	5	8.5
12. Tufts	265	28	10.5	285	49	6.8
13. Howard	276	33	12.0	103	3	1.5
14. Georgetown	619	115	18.5	210	21	5
15. Loyola	254	53	20.9	267	25	4.7

Of the 8,954 candidates thus studied, 620 failed, an average of 6.9 per cent. when the local state results

[1] From the Departments of Pathology and Bacteriology, Louisiana State University and St. Louis University Schools of Medicine.

[2] Albert E. Casey, "Influence of Individual North American and British Journals on Medical Progress in the United States and Britain" (in press).

were eliminated. Three hundred and twenty-nine of the failures were in New York and Massachusetts. The remaining 291 failures were in other states, giving averages of 19.9 per cent. for the former and 4.0 per cent. for the latter states. With an average failure of 7 per hundred candidates, it was necessary to have a sample of 200 candidates for statistical analysis. Only 15 schools had as many as 200 candidates examined by other than the local state boards. The 15 schools were listed in the order of their percentage failures on state boards, alongside of the number of papers published in the thirty-six most quoted medical journals for the period March, 1932, to March, 1934 (Table II). It will be seen that a very high inverse correlation existed between the percentage of failures of the students on state board examinations and the publications of the faculty in leading national journals (Fig. 1). There was no correlation between the

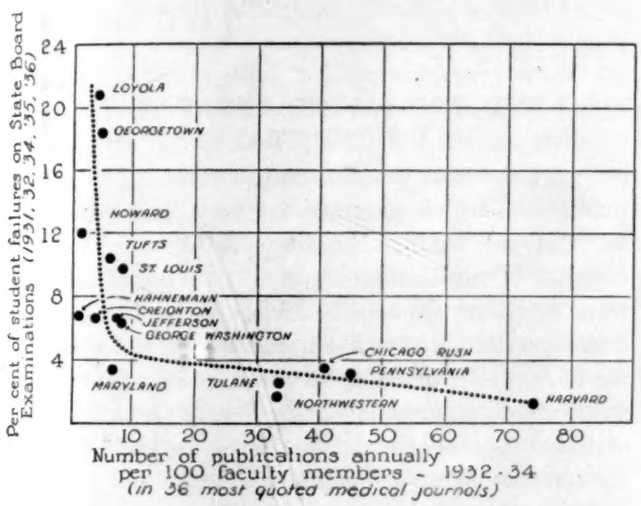

FIG. 1

number of faculty members and the failures on state boards or between the number of faculty members and the scientific output. Less than 20 publications for 100 faculty members in the 36 leading medical journals should be a clear warning to school authorities that all is not well in their school and drastic changes should be instituted. The medical schools in the various state universities generally did not supply a sufficient number of candidates for analysis. Most students from such state schools reside in the state of graduation and are not as likely to take out-of-state medical board examinations. Sufficient time has elapsed so that the standing of the schools to-day need not necessarily be that of 1934. It is believed that the high inverse correlation between the research activity of the faculty and the failures of the students on state boards should be brought to the attention of faculties and administrators.

ALBERT E. CASEY

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ON THE ORIGIN OF THE DOMESTICATION OF THE DOG

EVIDENCE of the domestication of the dog reaches as far back as the Neolithic. In the early Neolithic period the skeletons of dogs are found outside the limits of human habitation sites. In Danish kitchen middens of the Maglemosian phase of culture such skeletons have been found in appreciable numbers within the habitation sites.

Students of the subject have for long been puzzled to find a satisfactory explanation for the original motive or motives which led to the domestication of the dog. It is likely that different motives may have been operative in different human groups. All people are fond of the young of wild animals, and it may well be that this fondness led to the making of a pet out of the puppy of the wild dog, and thus to the domestication of this eminently domesticable animal. An examination, however, of the role played by the dog in different human groups at different levels of cultural development shows that the "pet" motive is not characteristic of all of them, whereas the motive of *use* is. Furthermore, the motive of *use* applies to all domesticated animals, even to the cat, which catches mice, rats, birds and other animals which are likely to be a nuisance. The keeping of pets merely as pets is probably a relatively recent development of civilization.

Of what use then could the dog have been to the men who first domesticated him? The evidence suggests that his first and primary use originally was as a scavenger. The earliest human groups were food-gatherers and hunters, with no agriculture or domestic animals of any sort. Living a semi-nomadic existence in search of food they would occupy a site until the food supply was dangerously diminished, whereupon they would move to another area where food was more abundant. At each of their camps or settlements they would throw the remains of their meals into heaps which often assumed considerable dimensions, depending upon the length of their stay and the numbers in the group. The odor from these middens must often have been quite overpowering. Hence, when it was discovered that the dog was a willing consumer of the left-overs from "kitchen" and "table," who would thus effectively serve to eliminate the intolerable odors which blew in from the refuse heaps, his assistance was permanently enlisted in this worthy task.

This explanation derives some support from the disposition of the skeletal remains of dogs in relation to the kitchen middens and the prehistoric settlements of Europe. But far stronger evidence for this explanation is to be found in the conditions existing among people of a Stone Age culture of to-day. I refer to the Australian aborigines.

In every aboriginal camp large numbers of dogs are to be found, the native dingo and the mongrels resulting from hybridization with the introduced dogs. Since they perform no obvious useful purpose it has always been assumed that their only function was to serve as pets. Reading, recently, W. H. D. Le Souëf's "Wild Life in Australia" (Christchurch, N. Z., and London, 1907), I came across a passage which very probably contains the real explanation of the aboriginal's domestication of the dog. Le Souëf writes:

> I used to wonder why the natives shifted their camp so often, but I don't now, as, although we were only in ours three days, the amount of evil-smelling refuse that the natives had thrown away close to the camp was considerable, and the odour was perceptible on the third day before the camp even came in sight, and being in thick scrub there was not much breeze to carry it off, and flies and ants were attracted in numbers. If we had had several dogs, instead of only one, it might not have been so bad.

Now, in every Australian camp the dogs *do* act as scavengers, but this fact has been overlooked as of no significance. It is only when an observer draws attention to what happens when only *one* dog is present in a small temporary camp, that we can perceive the real importance of the dog in the social life of the individual and of the group.

It is not the stench alone of the decomposing refuse, but the flies and insects and other noxious creatures which this attracts that the dog tends to eliminate, to such an extent indeed that he becomes indispensable. It may be suggested that it was probably the same or a similar complex of reasons that led to the domestication of the dog elsewhere in the world.

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FIRST CASE OF HUMAN INFECTION WITH MESOCESTOIDES

SOME tapeworms recovered from a 13-months old white child at Nacogdoches, East Texas, recently referred to me for identification, were found to belong to a species of Mesocestoides. This constitutes the first record of infection of any Primate with adults of this group of tapeworms. The specimens found conform closely in most respects with a species recently found by the writer[1] in raccoons in East Texas, which were referred to the species *M. variabilis* Mueller, 1927, 1928, previously known from foxes and skunks. Species of Mesocestoides are characteristically found in carnivores and birds of prey, although one species, *M. latus* Mueller (1927, 1928), occurs in opossums and another, *M. corti* Hoeppli (1925), has been reported from the house mouse. The full life history of these tapeworms has not been elucidated; a larval sparganum-like form known as a tetrathyrideum has been found in insectivorous reptiles, birds and small mammals, but it seems probable that there is an earlier larval stage in an arthropod. The human infection, however, was probably derived from eating the improperly cooked flesh of some animal harboring the tetrathyrideum stage.

The worms recovered from the child were stated to total over 35 feet, but individual worms have an estimated length of about 40 cm, with a maximum diameter of less than 2 mm. The child harbored the worms for at least several weeks. She was fretful and anemic, had a poor appetite and complained of abdominal pain. The worms were apparently all expelled after two treatments with oleoresin of Aspidium, and the symptoms disappeared. A fuller report, with a description of the worms, will be published elsewhere.

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[1] A. C. Chandler, *Jour. Parasitol.*, 28, 227–231, 1942.

LAND AND WATER AREAS OF THE UNITED STATES

THE Bureau of the Census has just sent to press a publication which provides the first basic remeasurement of the land and water area of the states and counties of the United States to be released since the work of Henry Gannett in 1881. In addition, for the first time, land and water areas are given for each of the 50,000 civil divisions of the counties, a fact which will provide a per-square-mile density basis for census statistics possessing sixteen times the refinement of comparable county densities.

This publication, which is the product of five years of planning, measurement and verification, employed procedures approved in conferences with the U. S. Coast and Geodetic Survey, the U. S. Geological Survey and the General Land Office. Greatly improved maps made it possible to undertake these remeasurements. This work was based on the 1937 series of the U. S. Coast and Geodetic Survey aeronautical charts on a scale of 1:500,000. The area of the United States by states was computed by using geodetic tables based on the Clarke spheroid of 1866 adjusted to conform to the legal ratio of 39.37 inches to the meter. The areas of all thirty-minute quadrilaterals falling entirely within each state, as given by these tables, were combined with the partial areas of thirty-minute quadrilaterals as determined by planimeter measurement. Counties shown on the U. S. Geological Survey and Post Office Department state maps, on scales of 1:500,000 and 1:750,000, respectively, corrected to conform to 1940 boundary conditions, were measured and adjusted to the state totals computed from the aeronautical charts. For the minor civil division and city areas, the best available

large-scale highway, post route, topographic quadrangle or miscellaneous map for each county was measured and adjusted to the county area totals. A basic contribution to the precision of area measurement is provided by adequate definitions of land and water and an objective system for establishing the outer limits of the United States in terms of readily duplicated criteria. The work on this project was initiated by and carried forward under the supervision of Clarence E. Batschelet and Malcolm J. Proudfoot, chief and assistant chief of the Division of Geography.

CHARLES C. COLBY

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SCIENTIFIC BOOKS

THE BASAL GANGLIA

The Diseases of the Basal Ganglia. Volume XXI of the Proceedings of the Association for Research in Nervous and Mental Disease; December 20 and 21, 1940, New York. 719 pp. Baltimore: Williams and Wilkins Company. 1942. $10.00.

THE year 1940 was a strategic time to hold a symposium on diseases of the basal ganglia, to bring to the attention of clinicians and physiologists that now at last this refractory field is beginning to yield to repeated attack. The volume issued by the Association for Research in Nervous and Mental Disease contains neither sweeping new revelations, nor the clear picture which may finally be put together out of the studies of many investigators working from different points of view. It does, however, contain new evidence and interpretations, both derived from, and leading to new methods of treatment. And already these are beginning to shape into a new understanding.

The nineteen papers which constituted the symposium vary greatly in length and quality, and unfortunately not all of them are significant as printed, whatever their significance in practice may be. In this medley a variety of points of view is represented. Read consecutively, there emerges a clear idea of the directions of development in the field, and also of the impediments; especially preconceptions, and the too facile use of ill-defined terms. There is probably no other field of organic neurology which is so handicapped by lack of agreement on the content of concepts and on the definition of terms.

Although the chapters are not grouped in the book, the symposium seems to have been organized in six parts: anatomy, physiology, pathology, both anatomical and physiological, non-surgical treatment and surgical treatment, with a lively historical introduction to the whole. The anatomical section runs true to form in concreteness and detail of evidence on a number of points. It is especially noteworthy, however, for Papez enlightened presentation of current concepts of neural organization of motor function in the brain stem, illustrating in this the slow molding of thought in response to painstaking anatomical analysis.

In striking contrast is the physiological section, in which concepts impinge with the still unchallenged authority of yesterday's successful experiment. Considering the physiologist's long defeat in the field, unequivocal positive results such as are presented in three of these four papers are cause for rejoicing, even though the evidence is still far from creating a picture of the working of the basal ganglia. The last of these papers, by Dusser de Barenne, Garol and McCulloch, is especially significant as a new departure in experimental attack.

Pathological anatomy has hitherto been the most rewarded field of investigation of basal ganglion disease, and perhaps not much new should be expected. It is gratifying, therefore, to find in Alexander's paper both new evidence on and an interpretation of *Status marmoratus* Striati, and a physiologically oriented reconsideration of the time factor in the development of basal ganglion syndromes.

As to pathological physiology: Goodhart's brief commentary, which accompanied a motion picture exhibition at the symposium, affects me like the account of the fine party which I missed. The film was to have been made available for teaching purposes, and should be invaluable for that, especially if it is a talking film. Hoefer's paper, also on pathological physiology, applies modern electro-physiological technique to the analysis of muscle function in dykinesias, both of basal ganglion origin and others, with results that should exact clarification of concepts and of terminology.

Non-surgical treatment of "basal ganglion disease" has been disappointing, and the section dealing with it corresponds. Nevertheless, the papers of Phelps and of Carlson, and the discussion following, raise questions which are here and there suggested in the rest of the volume, but not clearly formulated. The personal and social aspects of these disorders will undoubtedly present problems long after their pathological physiology is reasonably well understood. The unexplored direction which I feel most strongly, looking back on the volume as a whole, is the emotional and psychic; the psychosomatic relationship. Throughout the clinico-pathological and clinical and

even the physical and anatomical papers evidences of this intrude, as it were, in many ways.

The section on surgical treatment is unquestionably the most exciting in the volume. The dramatic quality of successful surgery, especially when novel, heightens this effect, but it is based on sounder considerations. As a side issue, surgery on humans, coupled with careful pre- and post-operative study, performs experiments which the physiologist has not yet duplicated. Two of the four papers in this section, those of Bucy and of Meyers, are physiological studies in this vein. However, the emphasis and main interest in all four papers is therapeutic. Klemme's paper contributes little, but the other three, culminating in Putnam's smooth presentation and evaluation of his own experience, leave one with the reasonable expectation that surgical attack, still largely in the experimental stage, will shortly lead to standardized procedures widely applicable to the relief of "basal ganglion disease."

Reviewing the volume as a whole, and as a research publication, it seems to have balanced adequately the requirements of presenting technical research on the one hand, and basic research on the other. In both these fields its largest service to the general reader will be to break down the isolation in which basal ganglion disease and function has hitherto been regarded, and to emphasize the coordinated nature of motor action, whether healthy or diseased. Especially does this volume dispense with the dichotomy between "the old motor system and the new"; basal ganglia and cortex. Yet only as the directions indicated in this volume are more fully explored in clinic and laboratory, may we expect to understand the contribution of the basal ganglia to total motor function. For unquestionably this book marks a beginning, not an end, of a phase in research.

SARAH TOWER

THE JOHNS HOPKINS
MEDICAL SCHOOL

UNCONSCIOUSNESS

Unconsciousness. By JAMES GRIER MILLER, Society of Fellows, Harvard University. ix + 329 pp. New York: John Wiley and Sons, Inc. 1942.

"THIS book," as the author says in his preface, "attempts to distinguish the various meanings of the word *unconscious* which have been used, and to describe and differentiate carefully the diverse sorts of human behavior which have been included under this term." No fewer than 16 meanings are distinguished, some of them being, as applied to the individual said to be unconscious:

Unresponsive to stimulation, either to a particular stimulus or to all (or most) of the stimuli present.

Undiscriminating, not responding differently to differences of stimulation.

Verbally unresponsive, unable to communicate any evidence of discrimination.

Inattentive to a stimulus, responding only automatically.

Acting involuntarily.

Lacking insight into one's motives for an act or reasons for a conclusion.

Unable to remember what one has experienced.

Unable to remember desires and ideas that have been "repressed" from consciousness because the individual is afraid or ashamed of them (the Freudian meaning).

Unaware of a given stimulus or act—the generic meaning for those psychologists who are willing to accept introspective evidence, as the first three definitions given above are those acceptable to the behavioristic psychologists.

The phenomena indicated by each of the definitions are reviewed at some length with a view to appraising the amount of reality embodied in each definition, and finally a tentative approach is made toward synthesis.

The body of the book contains a large number of interesting discussions. For example, there is the neurological question whether consciousness is peculiar to the cerebral cortex or any particular part of it, to the hypothalamus or to the nervous system or organism as a whole. There seem to be higher and lower levels of conscious behavior, and "it is best to picture . . . consciousness (awareness) as migrating from place to place, being present in whatever region of the nervous system is at that time the location of the highest integration of the total behavior."

As to remembering and forgetting, the question is considered whether there is such a thing as "simple forgetting," an atrophy through disuse. Without dealing quite fairly with the evidence—as it seems to the present reviewer—the author rejects simple forgetting in favor of such factors as interference, repression and the reorganization of memory traces by an unconscious dynamic process.

The author's method, in general, is to bring together the problems and observations of the psychiatrists and clinical psychologists and the experiments of the laboratory psychologists offering some light on these problems. These two types of psychology have gone on side by side for many years without much contact with each other, though the desire for such contact has been expressed from time to time. The author's freedom from partisan heat, combined with his clear and fearless presentation of the issues, open the way for frank discussion with the hope of fruitful investigation of this kind of problem.

R. S. WOODWORTH

COLUMBIA UNIVERSITY

SOCIETIES AND MEETINGS

THE VIRGINIA ACADEMY OF SCIENCE

THE twentieth annual meeting of the Virginia Academy of Science was held in Roanoke on May 7, 8 and 9, with Dr. George W. Jeffers, Farmville State Teachers College, presiding. There were 483 registered and 192 papers presented in the 10 sections, a new one for bacteriologists having been organized this year.

Dr. J. D. Schumacher, co-chairman of the local committee, presided as toastmaster at the annual banquet and Dr. W. H. Sebrell, of the National Institute of Health, was the principal speaker. Dr. R. N. Jefferson, of the Virginia Polytechnic Institute, was awarded the Jefferson Prize for an outstanding paper, "The Influence of Carbon Tetrachloride on the Toxic Efficiency of Certain Volatile Compounds." An engrossed scroll was presented to Dr. Roy J. Holden for long and constructive service as professor of geology at the Virginia Polytechnic Institute. The scroll was presented to Dr. Holden on behalf of his many friends by Dr. E. C. L. Miller, secretary of the academy since its organization.

The following officers were elected for the coming year: Dr. Marcellus H. Stow, of Washington and Lee, *president;* Dr. E. C. L. Miller and Dr. Sidney S. Negus, of the Medical College of Virginia, *secretary-treasurer* and *assistant secretary,* respectively; Dr. Arthur Bevan, state geologist, and Dr. John H. Yoe, *new members of the council;* W. Catesby Jones, chief chemist for the state department of agriculture, *president-elect.*

While the senior academy members were meeting at the Hotel Roanoke, 192 members of the junior academy met at the Jefferson Senior High School. The theme for this meeting was "Science in National Defense" and was developed through a science exhibit, two radio broadcasts, motion pictures, a lecture on chemical warfare and talks by members of the senior academy.

Of the fifteen exhibits, one on "Photomicrography" by students of the Andrew Lewis High School, Salem, was awarded first prize. Science club members of Jefferson Senior High School won second prize with an exhibit of minerals and Arlington High School pupils took third prize with an exhibit, "Fun with Trees." Newly elected officers of the Junior Academy are William Garth, Jefferson High School, *president;* Hope Christian, Appomattox High School, *vice-president;* Byron Stokes, Warren County High School, Front Royal, *secretary.*

SIDNEY S. NEGUS

THE SOUTHEASTERN SECTION OF THE BOTANICAL SOCIETY OF AMERICA

THE third annual summer meeting of the Southeastern Section of the Botanical Society of America was held on June 12, 13 and 14 at the University of Tennessee, Knoxville, with 44 members and visitors participating.

The program, arranged by Dr. Samuel L. Meyer and Dr. Stanley A. Cain, of the University of Tennessee, featured the botanical attractions and activities of the Knoxville region. First the party toured the T. V. A. forestry laboratories and tree crop nurseries at Norris. After luncheon at the Norris Dam, the group returned to Knoxville for an inspection of the Tennessee Agricultural Experiment Station. For the evening program, Dr. Cain presented "The Tertiary Nature of the Southern Appalachian Forests," and Dr. A. J. Sharp, of the University of Tennessee, showed "Highlights of the Southern Appalachian Flora" with Kodaslides.

The second day was spent in the Great Smoky Mountains National Park. One party hiked through virgin hardwood forests to Ramsey Falls, while others climbed Brushy Mountain, a part of Mt. LeConte. The botanists' dinner was held that evening at the Mountain View Hotel, Gatlinburg. Dr. W. H. Camp, of the New York Botanical Garden, delivered the invitational lecture, "The Origin and Genetic Structure of Species, with Special Reference to the Flora of the Southeastern States."

The program for the last day was an auto excursion through the Smokies. The botanists were welcomed at the park headquarters by Mr. Arthur Stupka, park naturalist, and were shown the park herbarium. The party then continued past New Found Gap to Clingman's Dome.

Dr. Julian H. Miller, of the University of Georgia, chairman of the section, presided at the business meeting on Friday evening. A set of proposed by-laws for the section was worked into suitable form and adopted, pending approval by the council of the society. The question of the place of botanists in the war effort, both civilian and military, was discussed. It was suggested that all helpful information on the subject be turned over to the secretary for distribution to the membership of the section.

The following officers for the section were elected for the coming year: *Chairman,* Dr. O. E. White, University of Virginia; *Secretary,* Dr. K. W. Hunt, College of Charleston; *Committee on Activities,* Dr. S. L. Meyer, University of Tennessee, *chairman,* Dr. F. A. Wolf, Duke University, and Dr. G. T. Weber, University of Florida.

KENNETH W. HUNT,
Secretary

COLLEGE OF CHARLESTON

REPORTS

COMMITTEE ON ANATOMICAL NOMENCLATURE

DURING the interval between the two world wars serious efforts were made to secure international revision of anatomical nomenclature. The Basle Nomina Anatomica, which was in official use in the Germanic countries, in Japan and in the United States, obviously required revision. This was undertaken by the Anatomische Gesellschaft, and a somewhat radical revision known as the NK and finally as NA was adopted for use in Germany. Meanwhile, the Anatomical Society of Great Britain and Ireland adopted its own revised nomenclature in English (BR), based largely on the old British tradition and very different from the BNA and NA. In the hope of avoiding further national separatism, an international commission on nomenclature was set up in 1936. This commission adopted the NA system as a basis for revision and requested suggestions for its work, which was to be considered for adoption at an International Congress of Anatomists in 1939 or 1940.

A committee of the American Association of Anatomists, under the chairmanship of Professor C. M. Jackson, gave careful consideration to this question for three years, and finally in 1937 submitted to the International Commission detailed proposals for a new nomenclature. These proposals took the form, as required, of suggestions for improvement of the NA; but they were based upon earnest consideration of both the German and British proposals as well as of the American view-point, and it was hoped that the American revision would help toward a truly international agreement. The American committee carefully avoided setting up this revision as a national standard, prior to international consideration, as unfortunately the British and Germans had done. Its report was therefore never published and exists only in manuscript.

The outbreak of war in 1939 stopped all such international efforts. Meanwhile the Germans and Japanese have adopted the NA; the British have adopted the BR; in Latin countries various vernacular nomenclatures largely based on the French tradition are still in use; and the United States anatomists alone continue officially using the BNA.

The present is hardly the time to dream of international action toward preventing this chaos in nomenclature; but it seems a clear duty that the American Association of Anatomists shall do what it can to preserve the valuable work of its committee for future use. It should be prepared to guide its own members, and others in our country who use anatomical terminology, through this unsettled time; and to help and, if necessary, lead in re-establishing an international nomenclature as soon as possible.

To that end the association, at its meeting in 1942, appointed George W. Corner chairman of its Committee on Anatomical Nomenclature to succeed C. M. Jackson, retired, with authority to reconstitute the committee. This has been done as indicated below.

All who are interested in these problems are invited to communicate with the committee.

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SPECIAL ARTICLES

THE ANTIGENIC PROPERTIES OF NATIVE AND REGENERATED HORSE SERUM ALBUMIN[1]

THE denaturation of serum proteins by such organic compounds as urea, or guanidine hydrochloride, is a pseudo-reversible reaction. If horse serum is denatured by concentrated urea solutions, and urea removed by dialysis, a water-soluble protein can be recovered which resembles the original, native protein in molecular size and shape, but differs from it in conditions of crystallization and yield,[2] in electrophoretic mobility on the alkaline side of the isoelectric point,[3] and in its response to the proteolytic action of trypsin.[4] This indicates that the apparently reversibly denatured, or "regenerated" protein, although akin to the native in size, shape and surface properties, is devoid of the specific intrinsic structure of the latter and, therefore, in a denatured state.[5]

Investigation of the immunological properties of native and regenerated serum albumin led to the discovery of fundamental differences in the antigenic

[1] This work was supported by the Rockefeller Foundation and by the Lederle Laboratories, Inc.

[2] H. Neurath, G. R. Cooper and J. O. Erickson, *Jour. Biol. Chem.*, 142: 249, 1942.

[3] D. G. Sharp, G. R. Cooper, J. O. Erickson and H. Neurath, *Jour. Biol. Chem.*, in press.

[4] F. Bernheim, H. Neurath and J. O. Erickson, *Jour. Biol. Chem.*, in press.

[5] H. Neurath, G. R. Cooper and J. O. Erickson, *Jour. Phys. Chem.*, 46: 203, 1942.

activity of these two fractions, as revealed by the response to antibody formation they elicit. In these experiments, two groups of large rabbits, of between 4 and 5 kg body weight, were given successive, intravenous injections of native and regenerated horse serum albumin, respectively, over a period of not less than four weeks. Antibody titer of the rabbit sera was determined by the optimal proportion method of Culbertson.[6] In several cases, antibody content was also determined by the method of Heidelberger and Kendall,[7] as well as by quantitative comparison of the electrophoretic patterns of normal and immune sera.[8]

Although individual variations in the response to antibody formation are apt to be great, nevertheless, with eleven animals that have been tested, the antibody titer of the sera of rabbits immunized with the regenerated serum albumin was, on the average, only 10 per cent. of that obtained by immunization with the native protein. In a typical pair of experiments, 1 cc of an anti-native protein rabbit serum was found to combine optimally with 1.23 mg of the homologous antigen whereas 1 cc of an anti-regenerated protein rabbit serum combined optimally with only 0.13 mg antigen.

While the regenerated protein is thus seen to possess a greatly reduced capacity to incite antibody formation, the immunological specificity of the native protein was not impaired by the regeneration process. This is borne out by the finding that native and regenerated protein not only exhibited strong cross reactions when tested with the corresponding antisera, but, in all but two cases, were actually immunologically equivalent. Immunological equivalence is defined, according to Marrack, as: "Two antigens A and B will be said to be 'equivalent' when the antiserum to A reacts in the same titer with both A and B, and vice versa."[9]

Preliminary measurements indicated the regenerated horse serum albumin to be completely non-antigenic in sheep, even when administered in fairly large amounts.

The present findings suggest that native and regenerated serum albumin differ from each other in antigenic activity but not in antigenic specificity, and that the antigenic activity of the native protein resides primarily in the very structural features that are altered or destroyed during the regeneration process.

This work is being extended in various directions so as to include the action of several types of denaturing agents on the albumin fraction of certain normal sera, and on the globulin fractions of normal and immune sera. A full account of the present findings will be published elsewhere.

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QUANTITATIVE INTERNEURONAL RELATIONSHIPS IN THE HUMAN SPINAL CORD[1]

BODIAN[2] has recently reviewed the problems in the field of synaptology, and to his excellent summary the reader is referred for introductory notes and bibliography. Among the problems requiring attention is that of ascertaining on a quantitative basis the interrelationships of the various cell groups in the human spinal cord. The determination of these values

TABLE 1

INTERNEURONAL RELATIONSHIPS IN THE HUMAN SPINAL CORD

Cell column	Number of adjacent boutons	Source of Adjacent Terminals (Number and per cent. of total for region)				
		Dorsal root	Substantia gelatinosa	Sensory and internuncial	Subcortical nuclei	Cerebral cortex
Sensory and internuncial (5,440,000 cells)	676,740,000	20 per cent. (135,348,000)	14 per cent. (94,743,600)	50 per cent. (338,370,000)	10 per cent. (67,674,000)	6 per cent. (40,604,000)
Nucleus dorsalis (188,600 cells)	65,632,800	65 per cent. (42,661,320)	10 per cent. (6,563,280)	15 per cent. (9,844,920)	10 per cent. (6,563,280)	0 per cent.
Intermediolateral (1,023,000 cells)	124,806,000	0 per cent.	50 per cent. (62,403,000)	40 per cent. (49,922,400)	10 per cent. (12,480,600)	0 per cent.
Somatic efferent (1,456,000 cells)	925,503,000	0 per cent.	5 per cent. (46,275,150)	65 per cent. (601,576,950)	20 per cent. (185,100,600)	10 per cent. (92,550,300)
Number and per cent. of total boutons contributed to cord cells from each source	1,792,681,800	178,009,320 (9.5 per cent.)	209,985,030 (11.8 per cent.)	999,714,270 (55.8 per cent.)	271,818,480 (15.2 per cent.)	133,154,700 (7.5 per cent.)

[6] J. T. Culbertson, *Jour. Immunol.*, 23: 439, 1932.

[7] M. Heidelberger and F. E. Kendall, *Jour. Exp. Med.*, 61: 559, 563, 1935.

[8] A. Tiselius and E. A. Kabat, *Jour. Exp. Med.*, 69: 119, 1939.

[9] J. R. Marrack, "The Chemistry of Antigens and Antibodies." London, 1938.

[1] Read before the American Association of Anatomists, New York, N. Y., April 2, 1942.

[2] David Bodian, *Physiol. Rev.*, 22: 146–169, 1942.

is attempted in the present study through observations on central bouton changes incident to known lesions in the central and peripheral nervous systems. The data on which the present computations are based have been presented in previous reports.[3,4,5] These data include: (1) determinations of cell size, number and surface area in the various main nuclear groups; (2) quantitative estimates of the number of boutons adjacent to individual cells, to cell groups and in the entire cord; (3) establishment of criteria of bouton alteration under pathological influence which include alterations in number (both increase and decrease) and alteration in morphology; (4) establishment of circumstances dictating the variable changes including direction of influence, effect of age, autolysis and technique, the part played by the duration of the pathological process, the fundamental nature of the pathology, and the bearing cell size may have on the effect; and (5) the establishment of patterns of bouton change peculiar to specific lesions or cord conditions. With this information at hand it is possible to relate alterations in specific locations to known lesions and deduce certain interrelationships which are presented in Table 1.

The restrictions imposed by dependence on chance lesions in human material have necessitated limiting these observations to only the main nuclear groups and their connections. Work is in progress as material comes in which suggests more explicit sources for the groups included in the sensory and internuncial cell columns and also in the somatic efferent columns. It should be pointed out that the quantitative data from control groups at all ages varies plus or minus 5 per cent. necessitating caution in interpreting 0 per cent. values which have been established through comparison with control averages. These values mean only that no change in the synapses at the designated locations is detectable with the technique used.

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GROWTH STIMULATION OF PEAS BY TETRACHLORO-PARA-BENZOQUINONE, A FUNGICIDAL SEED PROTECTANT[1]

THE first strictly organic, non-metallic compound to show much promise as a plant protectant against fungous diseases was tetrachloro-para-benzoquinone. In field tests made on pea seed during the past three years, it has very effectively prevented seed decay by soil-inhabiting fungi and has usually induced better yields than metallic compounds of equal fungicidal potency (cuprous oxide, hydroxymercurichlorophenol and ethyl mercury chloride). In tests made under conditions where there was no seed decay, it was the only treatment that increased the yields. The plants from pea seed treated with tetrachloro-para-benzoquinone yielded 9 to 22 per cent. more than untreated controls.

The treatment apparently stimulated the peas in many field plots since the plants were brighter green in color, made more terminal growth and frequently had stronger stems. Such field observations can not be accepted as proof of stimulation because a fungicide such as tetrachloro-para-benzoquinone might promote growth by preventing any one of several diseases of the seeds and roots. As a matter of fact, it has been found that both it and the metallic fungicides frequently increase the yield per plant by preventing post-emergence seed decay, a deleterious but frequently overlooked aspect of the seed disease problem.

In order to prove that tetrachloro-para-benzoquinone was stimulating the plants, it was considered necessary to test its effect on seed in the absence of disease organisms. Disease-free seed were treated with it and other fungicides and then sown alongside untreated seed in steamed soil in the greenhouse. Plants of the varieties Surprise, Wisconsin Early Sweet, Thos. Laxton, Alderman and Perfection have consistently produced 5 to 20 per cent. more dry matter in a 3 to 4-week growing period when grown from seed treated with it than from untreated seed. The other fungicides did not increase the growth of the plants. The seeds and roots of the controls were as healthy as those in the various treatments.

Typical results were obtained in a test with the variety Surprise, using 5 replications of 100 seed each. After 23 days, the average yield of dry plant tissue was: from untreated seed, 9.6 gm; red cuprous oxide, 9.9 gm; hydroxymercurichlorophenol, 9.7 gm; tetrachloro-para-benzoquinone, 10.9 gm; and yellow cuprous oxide, 9.3 gm. A difference of 0.8 gm was significant at the 5 per cent. point in an analysis of variance. The differences in yield were due to differences in growth rates, since there was almost identical emergence (97 to 98 per cent.) from the various treated lots. On the other hand, when seed from the same lots were planted in soil infested with *Pythium ultimum*, all four fungicides increased the emergence by 23 to 25 per cent. and consequently improved the yields. Tetrachloro-para-benzoquinone gave the largest yield increase under these conditions.

These data obtained under controlled conditions provide a suitable explanation for the results ob-

[3] Jeff Minckler, *Anat. Rec.*, 77: 9–25, 1940.
[4] *Ibid., Arch. Neurol. Psych.*, 45: 44–55, 1941.
[5] *Ibid., Am. Jour. Path.* (in press).

[1] Approved by the director of the New York State Agricultural Experiment Station for publication as Journal Paper No. 513, June 1, 1942.

tained under field conditions.[2,3] Tetrachloro-para-benzoquinone serves in the dual capacity of seed protectant and growth stimulant when applied to pea seed. Like any other good seed protectant it can increase the yield under severe disease conditions by preventing seed destruction. In addition, it can stimulate plant growth even in the absence of disease. From a practical view-point this is tremendously important. Heretofore, seed treatment has been recommended as a form of crop insurance against disease because it is needed in one of every three or four fields. As a growth stimulant, the material should pay dividends in practically every field, irrespective of disease conditions. It is of interest to note that the need for such a dual treatment has been previously recognized, and attempts have been made[4] to secure it by using a mixture of a fungicide and various plant stimulants.

It is not known how many species of plants will give the same response to tetrachloro-para-benzoquinone as peas. There is good circumstantial evidence from field observations that lima beans[5] and sweet potatoes[6] may be stimulated, but positive proof has not yet been provided. These field tests and the experiments described herein were made with the commercial product sold under the trade-name of Spergon, which contains one per cent. of a buffering agent. It has been shown that the growth stimulation of peas is dependent on the fungicide and not the buffering compound.

These observations on growth stimulation are of considerable fundamental significance, since they reveal a promising new field of study into fungicides. Further study is needed on the various halogenated members of the quinone series to see if they have properties similar to tetrachloro-para-benzoquinone and whether the growth stimulation and fungicidal properties are dependent upon one and the same chemical grouping within the compound. There is an outside possibility that the growth stimulation comes from decomposition products of tetrachloro-para-benzoquinone, since it is relatively unstable in alkaline media such as some of the soils used in these tests. Regardless of the exact relationship of chemical structure to biological responses, these observations point to a field of study in which both plant pathologists and plant physiologists are vitally concerned.

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[2] G. L. McNew, *The Canner*, 92 (6): 56, 1941.
[3] E. G. Sharvelle and B. F. Shema, *Phytopath.*, 31: 20, 1941.
[4] H. E. Croxall and L. Ogilvie, *Jour. Pomol.*, 17: 362, 1940.
[5] G. L. McNew, *The Canner*, 94 (17): 10, 1942.
[6] O. H. Elmer, *Plant Dis. Rep.*, 26: 44, 1942.
[1] E. N. Harvey and A. L. Loomis, *Biol. Bull. Marine Biol. Lab.*, 55: 459, 1928.

SCIENTIFIC APPARATUS AND LABORATORY METHODS

THE BIOLOGICAL APPLICATION OF FOCUSED ULTRASONIC WAVES

HIGH intensity ultrasound above a frequency of 500 kilocycles can best be produced through driving a quartz crystal to expand and contract along its x-axis by an alternating current which is timed to the same frequency of the crystal. The lethal effects of such supersonic waves were first carefully studied by Harvey and Loomis[1] 14 years ago. They used a 50-kilowatt power source and produced rapid death of bacteria and red blood cells in suspensions and of frogs. Since that time many biological and industrial applications of supersonic waves have been found, such as the sterilization of solutions, the homogenizing of oil-aqueous mixtures and of molten metals which would otherwise be immiscible.[2] In all these applications the sound waves have been allowed to proceed in parallel paths from the flat surface of the quartz crystal generator and no effort has been made to increase their intensity and local effect by bringing them to a focus. The authors' studies have utilized the curved quartz crystal method of Greutzmacher,[3] developed in his physical laboratory, and applied it with various improvements and adaptations to the production of focal changes in non-living as well as in living biological material.

The apparatus is essentially an 835 k.c. radio transmitter which provides the radio frequency current for driving the focusing crystal in the ultrasound generator. Ordinary 110 v. 60-cycle current is transformed, rectified and fed into the plate circuit of the first or oscillating stage of the radio frequency generator. This is kept stable, and all tuning is eliminated by introducing into the circuit a master control crystal which has been ground to exactly the same natural frequency as the ultrasound crystal, namely, 835 k.c.[4] After passing through a final amplifying

[2] Ludwig Bergmann, "Ultrasonics and Their Scientific and Technical Applications," p. 264. Translated by H. Stafford Hatfield. New York: Wiley. 1939.
[3] J. Greutzmacher, *Z. Physiol.*, 96: 342. 1935.
[4] This circuit was designed by A. E. Miller, Piezo-electric Laboratories, North Bergen, N. J.

stage, the radio frequency current is fed through condensers into the ultrasound generator.

The generator consists of the crystal and its holder housed in a transparent bakelite container which is filled with transformer oil kept cool by water circulating through copper coils. The entire generator is attached to a universal joint on the end of a flexible extension arm which permits its safe and ready application to living biological material. The design of the crystal holder permits maximum freedom from dampening and torsion effects, the maintenance of an oil-tight air chamber behind the crystal with doubling of ultrasound output, and finally, it permits the operator to vary the position of both crystal and holder with respect to the container and so vary the depth of application of the focused ultrasound. The focused beam of sound passes out of the generator through a Cellophane diaphragm and into any living or dead specimen which has been applied to its outer surface.

Results

Propulsion of oil: The activity of the focused ultrasonic waves was made visible by floating a film of oil on the surface of the diaphragm. When the current was turned on, the oil was driven upward in a conical column, its height being roughly proportional to the radio frequency current applied to the crystal. A large number of experiments of this nature were performed with single curved crystals and mosaics, mounted so as to focus on a common point.

Paraffin wax blocks: Preservation of the conical effect in solid form was obtained by placing cubes of paraffin wax or beeswax of known melting point on the diaphragm over the point of focus. Perfect cones were melted out of the wax blocks if low intensity current was used over a long period of time. The authors were naturally interested in obtaining a maximum melting zone at the point of focus with a minimum effect at the base, since the focal effect would be much more useful biologically. This was obtained by utilizing an ultrasonic beam of maximum intensity applied for a few seconds only.

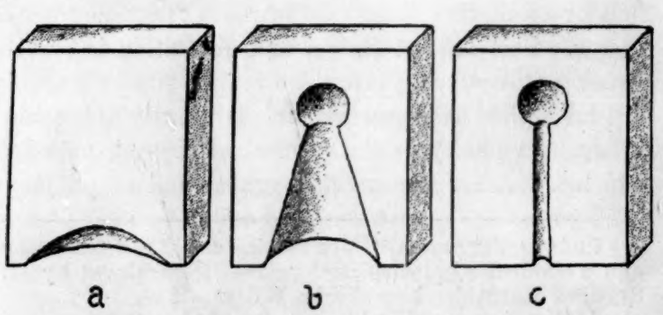

FIG. 1. Melting defects in paraffin blocks produced by focused ultrasound. (a) Low intensity for 30 seconds; (b) medium intensity for 30 seconds; (c) high intensity for 10 seconds.

Animal tissues: Blocks of fresh animal tissue were also treated, and liver was found to give the best results because the heated portion "cooked" whitish-brown, leaving the rest of the liver a deep maroon color. On sectioning, it was easy to see with the naked eye not only the area of basal absorption where the liver was in contact with the diaphragm, but also the more deeply situated focal region of high ultrasonic concentration. Examination of sections under a microscope confirmed the effect of focal destruction of cells.

Living animals: The production of lesions in living animals is made more difficult by the fact that circulating blood absorbs and disperses ultrasonic waves to some extent. The brain of the dog was chosen for the experiment because any destructive effects would be apparent by disturbed motor activity as soon as the animal was allowed to come out from under the anesthetic. In spite of the probability that the focus was not sharp because of refraction from the solid bone and tissue phases of the head, positive results were obtained. By the transcranial application of focused ultrasound to the appropriate areas of the cerebral cortex, disturbances in muscular coordination, some paralysis and in one case blindness were obtained in association with corresponding gross and microscopic brain lesions. Unfortunately, there was always a necrosis of the scalp where the apparatus was applied.

Conclusions

An apparatus for the production of focused ultrasound has been constructed and applied to biological material. Focal lesions were produced in fresh tissue and living animals.

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BOOKS RECEIVED

GRABER, L. F. and H. L. AHLGREN. *Laboratory Manual for Students of Agronomy.* Third edition. Illustrated. Pp. 155. John S. Swift Co., Inc., St. Louis, Missouri. $2.00.

Highway Research Board: Proceedings of the Twenty-First Annual Meeting—1941. Illustrated. Pp. viii + 561. National Research Council.

Molecular Films, the Cyclotron, and the New Biology. Essays. Illustrated. Pp. 95. Rutgers University Press. $1.25.

RANDALL, MERLE and LEONA ESTHER YOUNG. *Elementary Physical Chemistry.* Illustrated. Pp. xiv + 455. Randall and Sons, Berkeley, Calif. $4.50.

RODGERS, ANDREW DENNY, III. *John Torrey.* Pp. 352. Princeton University Press. $3.75.

SKLÁDAL, J. *The Pleuro-subpleural Zone.* Illustrated. Pp. vii + 103. Cambridge University Press: Macmillan, N. Y. $2.75.

WALLING, S. A. and J. C. HILL. *Aircraft Mathematics.* Pp. 189. Macmillan. $1.25.